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New England Water Works Association.

1935—1936.

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THE ASSOCIATION was organized in Boston, Mass., on June 21, 1882, with the object of providing its members with means of social intercourse and for the exchange of knowledge pertaining to the construction and management of water works. From an original membership of only TWENTY-SEVEN, its growth has prospered until now it includes the names of 800 men. Its membership is divided into six classes, viz.:

A Member shall be an officer or employee of a public or private water works, an engineer, chemist or other person qualified to aid or interested in the advancement of knowledge relative to water works.

An Honorary Member shall be a person of acknowledged eminence in some branch of water supply or of engineering.

A Life Member shall be a member whose service to the Association entitles him to special recognition by the Association.

A Junior shall be not less than eighteen years nor more than twenty-five years of age, a student or connected with water supply work.

An Associate shall be either a person, firm or corporation engaged in manufacturing or furnishing materials or supplies for the construction or maintenance of water works.

A Corporate Member shall be either a Water Board, Commission, Company or Municipal Corporation.

The initiation fees and annual dues are as follows:

Initiation Fees		*Annual Dues*	
Members	$ 3.00	Members	$ 6.00
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RIGHT AT GRAND CENTRAL — FRANK J. CROHAN, President

MEMBERSHIP

As announced by President Esty at the November meeting of this association, a membership campaign has been launched. Under the enthusiastic leadership of Mr. Harold L. Brigham, this committee can achieve success only with the cooperation of each individual member.

There is a reciprocal advantage in this undertaking. For the new member, the association offers an invaluable opportunity for social and professional intercourse with other men in the water works field; and enables him through the Journal, to be in touch with recent developments in this field. For the association, it means new blood to stimulate interest in its various committees, research, and services.

It should be the proud duty of each member to do his share in making the NEW ENGLAND WATER WORKS ASSOCIATION even more successful, by helping to enlarge its proper scope of action.

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New England Water Works Association

ORGANIZED 1882.

Vol. XLIX. December, 1935. No. 4.

This Association, as a body, is not responsible for the statements or opinions of any of its members

FIRE SERVICE CHARGES.

BY H. E. HALPIN.*

[*Read May 16, 1935.*]

The subject of fire service charges has been discussed widely in the water works profession for many years, although during the past ten years it has been given little consideration by the New England Water Works Association. There has been and is today a wide variation in the practices of water works in levying charges for public and private fire service. The purpose of this paper is to review the current practices of the water works in New England and to this end, information has been collected from 177 water works by means of a questionnaire. The number of replies is sufficient to give a good idea of the current practice. There are two general classifications of fire service, public and private.

Public Fire Service.

Public fire protection is a governmental function and for this purpose public fire departments consisting of apparatus and men are maintained by municipal funds. We all know that public fire protection requires additional capacity in the water works system in the form of water storage, pumping equipment, a distribution system sufficient to supply the fire demand simultaneously with the maximum domestic demand, and other appurtenances.

The studies of Metcalf, Kuichling and Hawley made about 1910, and referred to widely in writings on this subject, indicate that in cities of less than 10 000 population about 60 to 80 per cent. of the entire cost of the water works plant is necessitated by fire protection requirements; in cities of 50 000, about 30 to 35 per cent.; and in cities of 100 000 population, 20 to 25 per cent. This investment creates certain fixed charges and there is also the operating charge created by the operation, maintenance and repairs attributable to fire protection.

Water Works Which Receive Revenue. The summary of data from the questionnaire (see Table 1) shows that 84 municipally owned water works in New England, or 64 per cent. of those which furnished the information, receive no revenue for public fire service, their income being almost entirely

*Engineer, Inspection Department, Associated Factory Mutual Fire Insurance Companies, Boston, Mass.

TABLE 1.— PUBLIC FIRE SERVICE — NEW ENGLAND STATES.

State	Number of Water Works Receiving No Revenue.			Number of Water Works Receiving Revenue.			Average Annual per Capita Revenue.*			Average Per Cent. of Gross Annual Revenue.*			Equivalent Annual Rental per Hydrant.*				
	Municipally Owned.	Privately Owned.	Total.	Municipally Owned.	Privately Owned.	Total.	Municipally Owned.	Privately Owned.	Total.	Municipally Owned.	Privately Owned.	Total.	Municipally Owned. (Average.)	Privately Owned. (Average.)	Total.		
															Maximum.	Minimum.	Average.
Maine	2	0	2	15	12	27	$0.73	$1.08	$0.88	14	18	15	$41	$56	$133	$16	$48
New Hampshire	10	0	10	4	4	8	0.58	0.96	0.83	20	13	15	20	46	90	9	33
Vermont	5	0	5	1	1	2	0.43	1.00	0.72	7	11	9	10	25	25	10	18
Massachusetts	59	0	59	19	9	28	0.71	1.03	0.82	12	17	14	21	52	95	4	31
Rhode Island	0	0	0	3	4	7	0.56	....	0.56	11	16	15	40	37	50	25	38
Connecticut	8	3	11	5	13	18	0.49	0.56	0.54	7	10	9	24	41	82	5	36
Total	84	3	87	47	43	90	....	....	....	....	....	....	....	....	....	....	....
Weighted Average	....	....	....	....	....	....	$0.66	$0.88	$0.76	12	15	13	$28	$47	....	....	$37

*Where revenue is received.

from the sale of water for domestic and industrial purposes. A large number of this group of water works is located in Massachusetts.

On the other hand, the questionnaire and other data which are available indicate that practically all of the municipally owned water works in Maine receive revenue for public fire service. Many of the water works in that state are known as water districts and are corporations. Their finances are entirely separate from municipal funds and water rates are under the jurisdiction of the State Public Utilities Commission. The water districts do not pay any property tax within the limits of the chartered territories. Some water districts which are serving territory outside of their chartered areas are in some instances required to pay taxes to such towns or municipalities. Thus, it will be seen that the payment to the water districts for public fire service is not merely a bookkeeping transaction.

Practically all of the private water companies in New England receive revenue for public fire service.

Average Annual per Capita Revenue. The questionnaire indicates that those municipally owned water works which receive any payment are receiving an average annual per capita revenue for public fire service of $0.66 and the privately owned water works $0.88. The average of all water works which furnished information on this question is $0.76 which compares favorably with a corresponding figure of $0.77 given in the Manual of the American Water Works Association in a table entitled "Summary of Data from Public Utilities Commission Concerning Annual Revenue from Public Fire Protection Service." This latter figure was computed from the charges of 649 water works which were located in 22 states and covered the period 1922–1924. Although there may have been changes in rates since that date, it can be reasonably concluded that the average per capital revenue for public fire service of those New England water works which receive any payments, approximates that received in other parts of the country.

Average Per Cent. of Gross Annual Revenue. The total cost of fire protection service as made up of the fixed and operating charges previously mentioned will range from about 20 per cent. of the gross annual revenue in the larger cities to 35 per cent. in the small municipalities. The questionnaire indicates that the municipally owned water works receive for public fire service an average of 12 per cent. of the gross annual revenue, privately owned water works, 15 per cent. and the average of the total water works reporting is 13 per cent. These figures are based only on those water works which receive revenue for this type of srvice. The average of no New England state as given in Table 1 is as great as the average per cent. of gross revenue which should be received, based on the actual cost of fire protection service. There are no states to the writer's knowledge except Wisconsin which have established rates which adequately compensate for the calculated costs of public fire protection.

Equivalent Annual Rental per Hydrant. This is a convenient basis for comparison of revenues received from public fire protection. The average

annual revenue per hydrant received by municipally owned water works in New England is $28 and by private water companies, $47. The average of all water works reporting this information is $37. The water works which receive no payments are not included in these averages. There is a wide variation in the "hydrant rental" of the 90 New England water works which reported receiving revenue for public fire protection, the minimum being $4.00 and the maximum $133. Most of the rates have been arbitrarily taken to approximate the "average nearby rate" or to guarantee a revenue to meet certain fixed charges. Few have been established with due consideration to the cost of the service.

Methods of Charging. The replies to the questionnaire indicate that practically all the water works under consideration receive their revenue on a "hydrant rental" basis. A lump sum for public fire protection is received by a limited number and the inch-foot basis is used by a few, particularly in Connecticut. No water works reported that its charge was based on the mile-of-pipe method. This latter method includes an annual allowance per hydrant for maintenance. The several bases of charges and their merits and short-comings are not outlined here as these are commonly known.

Considerable progress could be made by replacing the "hydrant rental" charge by one based on the inch-foot units of pipe in the distribution system with an annual allowance per hydrant for maintenance. The inch-foot method is considered to be the most equitable method of charging yet developed and is coming into increasing use. The number of "inch-foot" units is obtained by multiplying the linear feet of pipe of each diameter by the diameter in inches. The rates of those few water works which reported on this basis ranged from $0.0044 per inch-foot unit plus $10 per hydrant to $0.01 per inch-foot unit plus $12 per hydrant.

Remarks. It probably would not be practicable to inaugurate charges for public fire service equivalent to the cost of the service at those water works which are now receiving no fire service revenue, but under favorable conditions it may be possible to make a start. In this connection, the following decisions of the Connecticut and Maine Public Utilities Commissions are of interest:

CONNECTICUT PUBLIC UTILITIES COMMISSION.

RE. GUILFORD CHESTER WATER CO. JAN. 23, 1928. P. U. R. 1928 C545

Commission said, in allocating revenue for fire protection service . . . Such allocations . . . should be paid by the several towns rather than by the other classes of water consumers, since the towns can distribute the burden by means of taxation where it equitably belongs, namely, on the property protected by the fire service.

MAINE PUBLIC UTILITIES COMMISSION.

BIDDEFORD & SACO WATER CO. *v.* ITSELF. 1920. P. U. R. 1920 B 580

Is there any person who pays a tax within the City of Saco, who is not directly interested in having each business place, and each residence within the district, served by the

Water Company, protected from the calamity of a conflagration? . . . We believe that the great majority of the citizens of Saco will readily acquiesce in the proposition that it is entirely fair to require the municipality to pay for its public service a just amount even though it slightly increases the tax to each freeholder.

Private Fire Service Connections.

There have been two divergent schools of thought relative to the merits of making charges for private fire service as shown in the three following extracts from Public Utilities Commission decisions.

Connecticut Public Utilities Commission.

New Haven Water Co. *v.* The City of New Haven Docket No. 5650–1932

Every connection made with the Company's distribution system adds to the demand on the Company's plant, even though the average consumption per year be not increased. In this case three elements therefore appear to be present warranting a reasonable charge for service:

(1) About fifteen pounds additional pressure resulting from the Company's recent improvements and developments.
(2) An additional demand on the Company's plant.
(3) Special and valuable service to those requesting and receiving private fire protection over and above the public fire protection, and which special service the Company is not legally obliged to render without just compensation.

Maine Public Utilities Commission.

Portland Water District *v.* Itself. P. U. R. 1917 D, 907.

The furnishing of private fire protection service by a water utility is one of its legitimate activities, and constitutes an important part of the general scheme it is intended to serve. This service can no more be rendered without the existence of a completed plant, than can any other service. The plant investment, upkeep, and operation are as essential to this as to any other. As between this and the other classes of service rendered by the utility, there is no reason why either class should be exempt from carrying its fair proportion of the whole burden. There is no more reason for exempting owners of these sprinkler systems from meeting their proper share thereof, than any other patrons of the city water works.

Public Service Commission of the State of Missouri.

City of St. Joseph *v.* St. Joseph Water Co. Case No. 6851, 1933

It therefore seems clear that the sprinkler user should not pay to the water company any charges which are based upon the cost of water and the cost of facilities to supply water for general fire protection purposes. The sprinkler user pays for this through his taxes.

There is, however, some additional expense caused by the sprinkler systems. It is necessary for the company periodically to inspect these installations, and in some cases to install meters, to insure that the water be not used for other than fire protection purposes. In some cases, some additional local equipment is installed by the Company, and each additional tap in the Company's mains, creates an additional weakness in the system. The sprinkler user should pay these costs, for they are additional expenses created solely by him.

On the subject of the reasonableness of the rate and the principles upon which charges should be made for sprinkler service, this Commission has previously spoken in a proceeding instituted by the very interests now before the Commission. That case is that of W. J. C. Kenyon, Manager Traffic Bureau, St. Joseph Commerce Club et al *vs.* St.

Joseph Water Company, P. U. R. 1921 D 590. Our decision in the Kenyon case was predicated on the idea that the sprinkler users received special benefits for the service rendered them by the water company and should therefore pay a reasonable charge, therefor.

It may be conceded that numerically the weight of commission and judicial authority is in favor of the special benefit doctrine announced by us in the Kenyon case. Yet, we are now convinced, after careful consideration of the subject, that reason and logic are against the views which we expressed there. Fundamentally, the basis of the special benefit theory is that because one user can get a greater benefit from the same water service than other users, the first should pay a higher rate. This seems to us unsound and if carried to its logical conclusion would result in gross discrimination and tremendous difficulties in the creation of rate structures. It would mean, for example, that the laundryman who makes a profit out of the use of water for washing clothes should pay a higher rate for the water than, say, the butcher who makes no pecuniary profit out of its use and so on through the whole category of uses of the water. As is pointed out most forcibly in the brief of counsel for the sprinkler users this theory has been repudiated in the case of rates charged for other utility services.

Installation Cost. The information collected indicates that it is general practice for the user to pay the entire cost of installation of the connection from the public main to the property line. The water departments are paying the entire cost in some municipalities and part of the cost, generally the meter if one is required, in other municipalities. Any investment by the water works in the connection from the main should be reflected in a proper charge to cover the interest and depreciation on the investment and the maintenance of the pipe connection.

Annual Charges. Replies to the questionnaire show that there is a marked difference in the practices of the municipally and privately owned water works. Two-thirds of the former make no annual charge for connections serving automatic sprinkler equipments, private hydrants and standpipes. Practically all of the latter make a charge. Data collected by the writer in 1930 from 545 municipally owned water works throughout the United States verify the recent figures obtained in New England, 58 per cent. making no charge.

Basis of Annual Charges. The seven bases used for making annual charges on private fire protection are shown in Table 2. No effort has been made to tabulate separately the bases of charges of the municipally owned and the privately owned water works, due to the limited number in each of the seven groups.

The flat charge or lump sum is most commonly used, 27 per cent. of the total reporting using this basis. The size of connection is a somewhat similar basis of charge and is used by 16 per cent. of those water works which reported making a charge. The remainder based their charges on outlets, either hydrants only, sprinkler heads only, or one of the several combinations indicated. The present practice could be simplified by using fewer bases of charges.

The report of a committee of this association on "Charge for Private Fire Protection" made in 1920,* states as follows: "In view of the fact that

*This JOURNAL, Vol. 34, No. 3, Page 219.

rates based upon analysis of cost, such as has been indicated, will cover all of the costs to a water utility, your committee is of the opinion that the service charge should be the only charge for fire protection,— that is, that there should be no charge based upon the number of fire hydrants, hose connections, sprinkler heads, etc."

In Case No. 6851, City of St. Joseph *v.* The St. Joseph Water Co., the Missouri Public Service Commission stated, "In the opinion of the Commission the rates to be charged for sprinkler service should be predicated exclusively upon the size of the connection to the Company's mains rather than upon the number of sprinkler heads upon the premises."

Amount of Annual Charge. As indicated by the minimum and maximum charges of the several groups in Table 2, there is a wide range in the amounts levied, extending from purely nominal to very substantial ones. This is particularly marked in the charges based on size of connections which range from $27.50 to $474.00 per year for 6-in. diameter and on sprinkler heads only which range from $0.02 to $0.18 each per year. No attempt has been made to average the charges. Such average figures based on the limited number of water works in each group would be meaningless.

TABLE 2.—PRIVATE FIRE SERVICE CONNECTIONS — NEW ENGLAND STATES.

Installation Cost Paid by.	Municipally Owned. Number.	Municipally Owned. Per cent.	Privately Owned. Number.	Privately Owned. Per cent.
User	77	79	28	78
Water Department (entire cost)	13	14	2	6
Water Department (part cost)	7	7	6	16
	97	100	36	100
Annual Charges: Yes	37	33	33	89
No	74	67	4	11
	111	100	37	100

Basis of Charges.	Number of Water Works Municipal and Private.	Per cent.	Amount of Annual Charge. Minimum.	Amount of Annual Charge. Maximum.	
Flat Charge	19	27	$5.00	$50.00	
Combination of Sprinklers and Hydrants	16	23	0.01 20	0.15 75	Per Sprinkler Per Hydrant
Hydrants only	12	17	10	50	Per Hydrant
Size of Connection	11	16	27.50	474	6-in. Connection
Sprinkler heads only	8	11	0.02	0.18	Per Sprinkler
Combination of Hydrants and Size Connection	2	3	20 50	60 120	Per Hydrant 6-in. Connection
Combination of Hydrants, Sprinklers and Size Connection	2	3	30 0.01 30	10 0.08 75	Per Hydrant Per Sprinkler 6-in Connection.
	70	100			

It has been found in this investigation and in a previous one by the writer covering a much larger number of water works that the charges of privately owned water works are substantially larger than those of municipally owned water works. The present study shows that there is no uniformity in the amount or method of charges for private fire protection. Many of the charges are undoubtedly determined by the amount of revenue desired, rather than the cost of the service.

Discussion.

Theodore L. Bristol.* We have eight fire service meters, four 8-in. and four 6-in. meters. Our capacity or service charges for meters per quarter are as follows:

Size—in.	Service Charge.	Size—in.	Service Charge.
⅝	$1.50	3	$43.50
¾	2.25	4	63.00
1	5.40	6	118.50
1½	13.50	8	190.50
2	18.00		

All our services are metered and it does not make any difference whether they are for fire service or for ordinary use of water. The charges apply just the same. On this basis, we are paid for all water used for meter testing, fires, leaks or for any other purpose. Water is paid for at the following rates:

First	2 000 cu. ft.	@ 20c. per 100 cu. ft.
Next	23 000 cu. ft.	@ 15c. per 100 cu. ft.
Next	75 000 cu. ft.	@ 13c. per 100 cu. ft.
Next	150 000 cu. ft.	@ 12c. per 100 cu. ft.
Next	750 000 cu. ft.	@ 11c. per 100 cu. ft.
Over 1 000 000 cu. ft.		@ 6c. per 100 cu. ft.

All our charges are made according to an order of the Public Utilities Commission of Connecticut.

Our experience in 1934 on a yearly basis was as shown by the following table. Two of the 6-in. meters are billed as 4-in. This is because when the meters were put in service, 6-in. meters were required by the insurance company but after our rates were increased, it was decided that the 4-in. meters would be sufficient. We, therefore, have kept the 6-in. meters in service because we had no use for them in any other place and it saved us the expense of buying new 4-in. meters and the expense of taking the 6-in. meters out and putting the 4-in. meters in.

*Ansonia Water Co., Ansonia, Conn.

1934 Fire Service Data — Yearly Basis.

Size—in.	Fixed Charge.	Cubic Feet Used.	Water Charge.	Total Charge.
8 x 4	$762.00	159 100	$212.76	$974.76
8 x 3	762.00	288 700	367.39	1 129.39
8 x 3	762.00	152 500	208.46	970.46
8 x 4	762.00	10 400	17.36	779.36
6	*252.00	9 200	15.22	267.22
6	474.00	20 100	31.53	505.53
6	474.00	600	1.20	475.20
6	*252.00	.....	.....	252.00
Totals	$4 500.00	640 600	$853.92	$5 353.92

*Billed as 4 in.

We have found that some of these fire service meters, particularly those that we put in fifteen or twenty years ago, are not very reliable as far as correct measurement is concerned, so it is well to test them and clean them quite frequently where there is any use, so as to ascertain if the meter is functioning properly.

HOW TO MAKE CROSS-CONNECTION SURVEYS?

BY WARREN J. SCOTT.*

[*Read May 16, 1935.*]

The topic proposed for this discussion is phrased to suggest a question rather than an answer. It seems to the writer very difficult to arrive at any one satisfactory method of making cross-connection surveys. The importance of periodic cross-connection surveys on every public water distribution system is so great, however, that any experiences along these lines should be of interest.

In Connecticut, the Public Health Council of the State Department of Health enacted sanitary code regulations in 1926 to govern cross-connections between potable and non-potable water supplies. Two or three of our municipalities had previously legislated locally against cross-connections. In 1926 and 1927 an intensive drive was made by local and state authorities to locate and eliminate cross-connections. Double check-valve installations, installed with facilities for periodic inspection and testing, were permitted on cross-connections then existing although the vast majority of cross-connections was eliminated. No new cross-connections are permitted. Recently the State Department of Health made an extensive check-up of factory drinking-water supplies, and in the course of this survey we located 34 cross-connections at industrial plants which had not been disclosed previously by local inspection. Other cross-connections have come to light in other ways.

About 3 years ago in a plant where double check-valves were installed on a fire line, a new connection was made outside of the checks to furnish city water under high pressure for the purpose of washing filters handling a polluted water used in process work and in some way flow conditions were reversed, causing pollution of the potable public supply at the mill and making a number of people sick. This connection was made since the original cross connection survey.

Last year we encountered an interesting case of a plumbing cross-connection in a house. Some poor bacteriological analyses of samples collected from one portion of a public water-distribution system led to an intensive survey of the district. We found two or three possible minor cross-connections. In one three-story house, the vertical pipes in the building were badly corroded. The bathtub in the third floor had an old-fashioned bottom inlet. The pressure due to pipe corrosion was very low on the third floor. After a tedious job of filling the bath tub, we opened a faucet on the second floor and not only did the flow stop to the third-floor bath tub but water siphoned out of the bath tub down to the second-floor faucet.

* Director, Bureau of Sanitary Engineering, Connecticut State Department of Health.

There are so many types of frequently encountered cross-connections that it is difficult to locate all of them. Perhaps the most common aside from plumbing connections are: industrial process-water supplies, auxiliary fire supplies in industrial plants, pump priming, auxiliary boiler feed, and private well supplies used for drinking or other purposes. In the case of private drinking-water supplies, cross-connected with public systems, the Connecticut State Department of Health does not require separation if the private supply looks and tests safe although we strongly recommend separation. We ask for periodic analyses of cross-connected private water supplies by the owners of these supplies. Public water-supply managements can insist on separation on the ground that they have no control over the private supplies. Swing connections are often used whereby either the public supply or a private supply can be turned into the house system with the use of an elbow and unions. With such arrangements, both supplies cannot be connected up at once.

The Connecticut State Department of Health strongly recommends that managements of public supplies make periodic surveys of their distribution systems to check up on possible cross-connections. The state sanitary code places a definite responsibility upon water-supply managements for existence of cross-connections, in that water officials are prohibited from supplying water to premises where there are cross-connections with supplies which are not approved by the State Department of Health.

Perhaps the first task in going about cross-connection surveys is to get track of auxiliary water supplies. This means not only the location of existing supplies at any particular time but also locating new supplies which may be installed on individual premises. We have for example some areas where the underlying porous soil furnishes a cheap ground water source from driven wells even though these wells may be located in thickly populated sections so that they are of questionable safety. Recently we had a case where a municipality in which a private water company operates, through its board of education put down some wells of this type in several schools with the idea of using the water for boilers and toilet flushing at a considerable saving for water charges against the use of the public water. Naturally dual supplies of this kind in schools are potentially dangerous due to the possibility of cross-connections in the future.

One possible source of information concerning new or contemplated private wells would be the local well drillers. These men, however, are somewhat in competition with a private water company in that every well prospect discouraged is a customer lost to them. Therefore, dependence on well drillers is not perhaps too reliable. One water works management contemplated and perhaps now has completed the sending out of return postal cards to consumers asking for information concerning any private supplies on the premises. This is cheaper than personal visits although probably not so dependable. Meter readers might be instructed to investigate cross-

connection possibilities in connection with their visits, although special training needs to be given them to make such work effective.

On large systems, it would be no extravagance to assign one or more men to the specific duty of investigating cross-connection possibilities by means of continuous surveys of premises, particularly in locations where private supplies may be numerous. Where there is perhaps only one stream flowing through a community, it may be known that only consumers near this stream could draw auxiliary surface water.

Some industrial plants have auxiliary tanks in the ground which are filled with public water, and these tanks may become contaminated due to defects in their construction. Drains to sewers from such tanks may be a possible hazard. We had an instance where a swimming pool was drained to a combined sewer in the street. One day the drain valve was opened and sewage backed up into the swimming pool from the sewer which happened to be flowing under pressure after a storm. The same possibility may occur in the case of water storage tanks.

The piping systems in some of our large industrial plants are worse than a complicated cross-word puzzle. Certainly one can learn little by walking into such plants and looking casually around. Some dependence must be placed upon the master mechanic or other responsible plant official. Unfortunately these officials die or change jobs. Maps prepared by the fire insurance interests are helpful frequently in tracing the larger lines and should be consulted and understood by the water works management. Our experience has been that very frequently persistent questioning of mill officials as to possible cross-connections, particularly on small lines, is needed to elicit information; not necessarily because the mill official has any intention of concealment but because he forgets about the connections from his auxiliary water supplies until he is brought to consider the question in detail. Our factory officials in Connecticut have been most coöperative.

While the writer is no advocate of double check-valves as against complete severance of cross-connections, it must be admitted that the public supply as a whole is safer with carefully maintained check-valves than in cases where double check-valve connections are not permitted but there is careless control over cross-connections which may be made in plants supposed to be free of any. In fact, double check-valves on supply lines to large industrial plants serve a very useful purpose in the event that cross-connections are inadvertently made inside the mill, or storage tanks holding water from the public supply become contaminated. It is not meant to imply that check valves should be considered as any excuse for careless maintenance, but even on lines supposedly free from potential cross-connection hazards they have a useful place. The ideal way is to look at these valves in the same light as we think of pasteurization of milk or chlorination of water from clean watersheds—not as an excuse for unsafe conditions but as an added safeguard. It goes without saying that too much dependence on check-valves—say in the case of separation from poorly constructed tanks

holding water from the potable public supply—may leave conditions which are very dangerous to industrial plant employees exclusive of considerations of the public at large.

Plumbing cross-connections can hardly be uncovered to any large extent by water company or department inspections. However, in large buildings, in stores and establishments other than houses, the possibility of plumbing cross-connection dangers should be especially borne in mind by the water superintendent. He may even find it possible to do a little educational work as to plumbing cross-connection dangers. Water works managements will do well in collecting samples from distribution systems for bacteriological examination, to select different sampling points and follow up occasional poor samples thoroughly to see whether near-by cross-connections, due to faulty plumbing or other cause, may be responsible. Frequent sampling of water distribution systems is a safeguard from the cross-connection standpoint.

There should be just as careful attention paid to dangers of pollution of water distribution systems by cross-connections as to dangers of pollution of our watersheds. As a matter of fact, most of the recent serious water-borne epidemics have been due to faulty distribution system connections. We employ watershed inspectors to safeguard our watersheds; why not cross-connection inspectors?

Discussion.

Charles L. Pool.* I would like to ask why Mr. Scott ended his title with a question mark, because the paper is a summation of experience, and packed in it is a great deal of valuable imformation. The intensive drive that was made in 1926 and 1927, I have reason to know, was as thorough and as extensive a program for elimination of cross-connections on a broad scale as has been done anywhere. I had the honor to be connected with it at the time, under Mr. Scott's direction; so that I can say from direct knowledge that the information in this paper is worthy of discussion and study.

To my mind, the way to make a cross-connection survey today is to make it continuous. That is, there should be a complete, thorough inspection at frequent intervals, and those of you who have the supervision of water supplies and who think that you have eliminated all the cross-connections on your systems should make the survey most complete, because it is almost impossible to be sure that all of the cross-connections have been eliminated without continuous follow-up by competent inspectors.

A Member. I would like to ask Mr. Scott what is the smallest double check-valve connection allowable in Connecticut, and if it must be of bronze.

Mr. Scott. We have two or three 2-inch connections, and a very few 4-inch connections. We have, I think, 165 sets of double-check valves in the state. We permit both the bronze valves and the special FM type of valves with the brass seats. I have forgotten the ratio of all-bronze to the iron-body

*Rhode Island State Board of Health.

valves. There are more iron-body valves than all bronze valves. Most of the newer ones are bronze, but we had quite a few of the special FM type iron-body valves before our regulations went into effect. We make tests of the valves three times a year, and the results have been a little better with the all-bronze valve, although they have not been very bad with the others.

PERCY A. SHAW.* We have a private water system in Manchester owned by the Amoskeag Manufacturing Company. They have 13 miles of their own pipe system and about 300 fire hydrants. We have two 14-in. connections with them, and one 8-in. and one or two smaller connections. Those are double check-valve connections. The only way I can see to eliminate them is to compel the Company to construct, or to construct ourselves, high elevated tanks and make them take their water from us through those high elevated tanks. We carefully inspect the double check-valve connections. Are we warranted in either spending all that money ourselves or in asking the manufacturing company to spend it?

MR. SCOTT. I think Mr. Chase ought to answer that.

E. SHERMAN CHASE.† That is a hard question to answer, and I can well understand why Mr. Scott did not want to answer it. Since I am no longer connected with the State Board of Health I can say what I think.

My opinion is that probably you are not warranted in asking the Amoskeag Manufacturing Company to go to that great expense, provided you make regular and constant inspection of those double check-valves and find that they are being properly maintained, if you find that they are not being properly maintained, then you can get after the manufacturing company and enforce more drastic methods of protection.

MR. SCOTT. In order that I may not be accused of avoiding a question, I will say that what Mr. Chase has said reflects the attitude of our State Department of Health. In the case of new plants, no new cross-connections are permitted. In the case of old plants, where the double check-valves are carefully maintained, and so long as our tests show that they are being well maintained and are doing good service, we have not taken the position as yet of ordering them out.

ARTHUR L. SHAW.‡ Perhaps the water works man's responsibility ends when he delivers pure and potable water at a given faucet which is marked as drinking water. In many plants which have dual supplies, one of which is potable and the other not potable, there are faucets where hose is connected for flushing, for watering lawns, and so on, and I do not believe there is a man here who has observed the use of such flushing streams who has not seen the laborer who is handling the hose on a hot day drink out of the hose. If the water is clear and cool he is going to drink it whether it is safe or unsafe. If we want to feel that our responsibilities go beyond that of merely delivering pure water at a fixed point, and accept further responsibility as public health officials, or people interested in public health, then I think we should see if there are not a lot of dual supplies which could be

*Manchester, N. H. †Of Metcalf and Eddy, Boston, Mass. ‡Of Metcalf and Eddy, Boston, Mass.

eliminated. Some of the big plants which have to use a tremendous amount of water for bleaching, and so on, of course perhaps are entitled to their own supplies, be they potable or not. But there are a lot of places which want to save money, which might better be required to take water from the public and potable supply and to have all water outlets in their mills potable.

MR. SCOTT. So far as Connecticut goes, we also have State sanitary code regulations which prohibit any mill from having faucets in the plant, available to the employees, where the water is not safe, except in a few questionable cases, when we have permitted signs to be posted. We have even gone so far as to ask some of the mills to extend their pipes in sinks down to a point where workers can't get at them.

I do not want to leave the impression that we do not pay attention to the conditions in the mills. I do not know what the regulations are in some of the other states, but I do think that the health departments as a whole are trying to get at the conditions in the mills and are not attempting to "pass the buck" back to the water departments for conditions in the mills that should have the attention of the health departments.

WATER RATES.

BY EDWY L. TAYLOR.*

[*Read May 16, 1935.*]

Considering the convenience of water piped into our houses, and that generally it is of the best possible quality, it is difficult to understand why there is ever any objection to rates charged for water service, for even the highest rates amount to little more than a few cents per day for the ordinary household. Possibly the objections come from those who have not experienced the inconvenience of drawing water from a well. Those who have carried buckets of water are quite glad to pay a reasonable amount for an unrestricted supply of water delivered through pipes.

In recent years in Connecticut there have been more complaints as to rates for water than for other public utility services.

The simplest form of water supply is that provided by an individual under a gravity system from a mountain stream to his property. In such case he pays the cost of the dam, the pipe line and the cost of maintaining it, and pays the taxes upon the improvement.

From this small beginning such a supply may be extended to be shared by two or more property owners, and in case one of them provides the capital investment, then they probably share equally all charges, namely, interest, taxes and depreciation, and the cost of maintenance. In any water system serving more than a few, it is more than likely that it would be inequitable to assess all the expenses equally against the customers served. Rate schedules set up for water properties have generally been established to avoid such inequities and to fairly allocate the cost and expense to the different types of service and classes of customers and even to the customers within the classes.

A water property must be designed and constructed to meet all the demands which the community it serves may put upon it, and these considerations effectually determine the cost of the property and expense for its operation. In determining rates for a water property, it is apparent therefore that the charges must be almost exclusively for service or readiness to serve rather than for water as a commodity.

Water works practice has been greatly advanced through the American Water Works Association and especially through its Manual, and while it is impracticable to adopt uniform practice in construction, management, administration and rate making, the recommendations in the Manual must be of great aid, especially for small operations. In these respects water works operation appears to be well in advance of the field of other public utility operations where such standardization has not been brought about, but, while due credit should be given to your industry, the greater progress

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through this New England Water Works Association and the American Water Works Association is chiefly by reason of greater age and thus a longer time to bring about the trend towards unified or recommended practice.

The convenience of, and increased possible use of, electric energy through appliances has tended to increase the amount of energy consumed and sold, and quite generally has tended to a reduction in rates, so that, in a consideration of electric rates, rarely is the issue raised that the charges are too high for the value of the service. Customers of gas properties generally have available other fuels, which, though they may not be so convenient, can be used at a lower cost than gas. This competition has tended to reduce rates for gas, so in this public utility industry also, though for a different reason, the issue is seldom raised that the charges are greater than the value of the service.

The establishment of rates for a water property differs materially from that of other public utilities in that the rate structure cannot be designed in a form to increase revenue by inducing the use of larger quantities of water except possibly by large users, so that, except for consideration of the very largest users, the form of schedule adopted only involves the consideration of producing adequate revenue and an equitable distribution of the charges upon the several classes of customers.

Rates, when fixed by a Commission, are generally established as maximum rates, and they must be just and reasonable alike to patrons, to the investing public, and to the utility corporation. A Commission has not only the power to investigate the reasonableness of existing rates, or proposed rates, but it may, if it should find such rates unreasonable, go on and prescribe what the rates shall be. A Commission acts in a quasi-judicial capacity in determining from evidence in a rate proceeding whether rates are reasonable. It is the obligation of a Commission to establish rates that will yield reasonable compensation for the service rendered, in other words it must see that the public gets what it pays for,—that the public pays for what it gets,—that the utility has earnings adequate to assure at all times the maintenance of its service, and the improvement and development of its property, and that the investing public receives a reasonable return. A Commission in so acting is performing a legislative function, and it is then doing for the legislature what the legislature itself could do.

The determination of rates by a Commission must be just and impartial and expert, because unreasonably low rates menace the interests of patrons, the investing public and the interests of the managers of the utility. Power given to a Commission over rates was not delegated by the legislature for the purpose of protecting one party or the other in a rate controversy, but to insure justice. Inadequate rates are certain to result in inadequate service, and then both rate payers and the utility suffer.

The present prevalent view that a Commission should be the advocate of the people is not tenable, and it was not the intention when Commissions

were established to create them merely for the protection of rate payers. Experience, especially that of recent years, has shown that public service corporations need protection against rate payers who resist any increase in rates, and who protest reasonable rates already established.

I believe it is the policy of your industry that the trend of rates shall be constantly downward, but it is conceivable that economic changes may not only stop this trend but reverse it by reason of increase in costs for labor and materials, in fact this has already been the experience of some companies. It is the duty of a Commission not only to avoid confiscatory rates but to allow the utility a reasonable return, and a larger return is justified if the service rendered is of high grade and the management of the utility is of the best and economical, for the allowance of a merely non-confiscatory return under such circumstances can not be considered good policy as it will tend to discourage these desirable virtues in utility management.

In many cases the United States Supreme Court has held that the value of the service to the customer is an element to be considered as well as the value of the property devoted to the public use. The Supreme Court has also held that no more shall be exacted of the user of the service than the service is fairly worth, and that the value of the service to the consumer properly takes precedence over the rate of return to the investor if these two rules conflict.

It is unusual for a Commission to have to determine a rate upon the basis of being all that the traffic will bear.

However, in one water rate case, the rates determined by the Maine Commission were fixed as the maximum the traffic would bear, where it allowed less than a fair return for the reason that industrial changes in the community had resulted in shrinkage of water consumption, and higher rates to yield a fair return would have been more than the remaining customers could have paid.

Under Commission regulation, the financial results from the operation of water properties may be compared to a form of contract which engineers have termed the "cost plus" type.

The Manual of the American Water Works Association, as is well known to you all, goes thoroughly into the allocation of the total investment to the several classes of service, public fire protection, private fire protection, domestic, commercial and industrial. There should be no free water service. All service must be paid for by some one. If any plant does not charge for all water service, including fire protection, then the charges to other customers must be above an equitable price and in every such case it is obvious that the rates must be unfair and discriminatory. Charges for private fire service are possibly the most difficult of fair determination. When such service to sprinklers and private hydrants is provided without metering, it should be represented by some form of service charge, and if such service is metered, the usual meter charge may not fully represent the cost of readiness to serve. This view is somewhat different from that taken by the

Connecticut Commission in the New Haven Water Company rate case, but that should not be treated as a precedent for there the whole matter of fire protection required special consideration.

Usually a schedule of flat rates should be applied only to small companies, although they can properly be used where there is no justification for restricting the use of water. Flat rates should be upon an equitable schedule which will provide a charge for each fixture or group of fixtures so that the total bill will be fairly proportional to the service and its use. The application of a rate per family or per house is almost certain to be inequitable.

The use of meters is the most satisfactory method upon which to base charges. In establishing meter rates, the most scientific and equitable method is to provide a minimum charge to represent the installation, fixed charges, maintenance of the meter and the customer costs such as meter reading and billing, with a minimum of $6.00 per year. There are and always will be objections to a service charge because of the feeling that the customer is paying something for nothing in a period when no water is used. However, as the service charge is quite generally accepted by Commissions and the Courts, and is approved by the United States Bureau of Standards, there should be no further doubt as to its propriety, and it should be used. It may be preferable from the standpoint of customer relationship to establish a meter charge which would include a small first block of water. A block form of rate in proper steps, including a lower price for each higher volume, is more satisfactory than a single rate which does not decrease with increase in volume of use.

The New England Water Works Association in 1916 seems to have been the pioneer in adopting a standard or recommended form of meter rate schedule. This embodied a service or meter charge and block rates in three or four steps for water delivered. These steps may be designated Domestic, Commercial, Manufacturing and Industrial, because a customer's volume of consumption would generally place him in the class of proper designation. It is recommended in the *American Water Works Manual* that the rate for the third block should be about one-half that for the first, with the rate for the second block midway between, and that the rate for the fourth block should be about one-third of the rate for the first block. Obviously, exact ratios between such rates cannot be uniformly prescribed because it is necessary to make variations to meet the requirements for producing revenue. In addition to this feature, local conditions as to availability of other water supply for customers, especially in the manufacturing and industrial classes, may quite definitely control the establishment of rates and thus make it necessary to vary materially from the ratios recommended in the Manual.

It is very difficult, if not impossible, to establish meter rates which will provide the proper amount of revenue for a water property without having experience data to indicate the water habits of the community served. I know of one case in which an eminent hydraulic engineer established rates

for a property which had previously been almost entirely on flat rates, and his predictions as to consumption were so far from correct that the meter rates fell far short of producing the required revenue. It is obvious that, if a few customers find they are paying less under new metered service than under old flat rates, there will be a rapid change from flat rate service to metered service. So it is important that, where both flat rates and metered rates are to be available to customers, they shall be set up on such a basis that charges for any customer under either schedule will be substantially parallel under the same conditions of use, and in case it is desired to induce a change-over from flat to meter rates, this can be accomplished by fixing the charges under flat rates somewhat higher than metered rates.

Quarterly billing is in quite general use, though there is nothing particularly to recommend it, and semi-annual or monthly billings are used by some companies, the latter being more convenient in a community where customers change with the seasons, while annual billing is possibly to be preferred in a seasonal community or under flat rate schedules.

Public ownership of water properties predominates in Connecticut, though the largest plants, except in the Hartford District, are privately owned. Public ownership of water properties may be as efficient and satisfactory as private ownership, but comparisons as to rates can not fairly be made between these two types without due consideration of free water service, the taxation of the water property, depreciation reserve, accounting and amortization of long term debt. Such municipal water properties as file reports with the Connecticut Commission generally keep adequate accounts, and provide adequate accruals for depreciation reserve. This is generally true of any such property which is managed under a separate bureau and is not subject to change in management with change in elective officials.

While a water property under public ownership can do all of its financing by issuance of bonds, if such financing is sound, the amortization of such bonds is essential, preferably by serial retirements; and the term of none of the bonds should be excessive.

A municipal water property should not be operated for profit; it should not yield revenue for other services in the municipality; if it does yield a profit, its rates must be inequitably established, making the customers of the water property pay some part of other people's taxes for the support of the community administration. This injustice is increased when the water property does not serve all of the taxing districts within the municipal limits. It is not unusual to find this profit-making considered as the main advantage of municipal operation.

Except under unusual circumstances, private capital is not invested in a water property with a view to capital gain or enhancement of income. The revenue of a water property in a well-established community is generally fairly constant though naturally the use of water and revenue therefrom vary to some extent with business conditions. The bonds of a well-managed

water property should provide security of capital for the investor and continuity of a fixed income, while the stock should provide security of capital and continuity of income subject to minor variations in amount, if any at all.

A privately-owned water property is most economically financed by substantially equal issues of stock and bonds, and provisions should be made for amortizing such bonds, preferably serially, and the term of none of the bonds should be excessive. The rates for a new property should be adequate to yield the fixed charges, that is, interest on the capital, amortization of the bonds, taxes, reasonable operating expenses, and ample accrual for depreciation reserve considered in connection with the amortization. For properties which have been in operation for some time, the rates should yield above reasonable operating expenses and accrual for depreciation reserve and taxes, a net return representing at least fair return on the fair value of the property used and useful in the public service.

It is doubtful that a Commission would fix a rate of return that just escapes being confiscatory in order that it may be a just and reasonable rate to the consumer, for as recently stated by the United States Supreme Court, "Present confiscation is not atoned for by merely holding out the hope of a better life to come." A Commission or other legislative body, in its discretion, may determine a rate to be reasonable and just when it is substantially higher than one merely sufficient to avoid confiscation, for even a stable industry like a water property involves some risk to the investor even though it may be remote and which cannot be foreseen, and the contingent risk must be compensated by a return which more than avoids being confiscatory. If a rate is non-confiscatory it is not necessarily just and reasonable. Rates substantially higher than the line between validity and unconstitutionality may properly be just and reasonable, and not excessive or extortionate.

In determining the rate of return, it is necessary to consider the character of service, the pressure, the dependability and continuity of the supply as well as the customer relationship and character of management, and when all or most of these features are favorable, a higher rate of return is justified. In fixing the rate of return, the financial condition and credit of the water property must be maintained. If it is disturbed, additional financing for expansion of the property may be impossible.

This very general outline of the fundamental principles of fair and reasonable procedure, which should guide a Commission in making rates for a water property, may well serve as a basis to be used by the management of a water property, and if these general principles are so applied, dissatisfaction of customers as to rates should be reduced to a minimum.

RECENT EXTENSIONS OF THE WATER SUPPLY OF GENEVA, SWITZERLAND.*

BY A. BÉTANT.†

Translated from the French by Gordon M. Fair.‡

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The problem of apportioning water to the various parts of a distribution network is sometimes easy, sometimes difficult, according to the extent of the network and the differences in altitude encountered. It is necessary that the pressure at each point in the region supplied shall not fall below an acceptable minimum, no matter what the altitude above and distance from a pumping station, assuming a service fed by pumping. The simplest case is encountered when we deal with a system of restricted extent in which the differences in elevation are not appreciable; it is then sufficient to lay pipes of adequate diameter that will keep the pressure drops from being excessive. But when the distribution system extends beyond a certain radius and supplies points situated at very different altitudes, the problem becomes much more complicated, because the differences in pressure and the pressure drops in long distribution lines then play a much more important part. The principal difficulty is to keep all the water sent into the network from being drawn into the low-lying portions of the region supplied, to the detriment of the high-lying portions which then receive only inadequate quantities. To avoid this danger, it becomes necessary to reduce the pressure at the low points more or less and to raise it artificially at the high points in order to attain a certain balance of the whole distribution system.

The development of the water supply of Geneva during the last few years furnishes a typical example of such a situation.

Geneva, a city of about 120 000 inhabitants, situated at the southern end of Lake Geneva, at the point where the Rhone River flows out of the lake (Fig. 1), draws its drinking-water supply chiefly from the lake. The average per capita consumption, based on a year's total, is 90 g.p.d. The power necessary to lift this water is furnished by the Rhone River on which a pumping station of 3 000 h.p. capacity was built in 1886 at Coulouvreniere. The water table is raised 180 ft. to supply the city proper and 460 ft. to supply the highest portions and those situated outside of the city. Although the water is naturally pure, it is chlorinated as a precautionary measure and will also be filtered in the near future. In the beginning, distribution of the water was confined to the city and its immediate surroundings. But little

*For a description of the main Geneva supply, see this JOURNAL, Vol. 35, (1921) p. 22.

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by little other places farther removed were linked to the network in an increasing radius, to such an extent that the distribution system today covers 34 communities and the network extends in a radius of about 9 miles around the station and includes 325 miles of pipe. The population served has reached a total of about 150 000.

This great expanse of distribution system has not been developed without creating numerous difficulties, for the difference in elevation between the various points served is as great as 525 ft., and when the pressure

FIG. 1.— MAP SHOWING THE SITUATION OF THE PUMPING STATIONS AROUND GENEVA.

was adequate, for the low-lying portions, it was not sufficient for the high-lying portions to supply which it became necessary to employ booster pumps. Another difficulty arose from the fact that the network traverses agricultural regions in which, during the summer, the irrigation of crops is carried on very intensively. This fact greatly affects the seasonal consumption: thus, while the mean annual consumption is 90 g.p.d. per capita, this rate can be raised, during the summer, to more than 185 g.p.d., *i.e.* to more than double the average.

For a certain length of time, the central station could satisfy these heavy demands; but there came a time when the station became inadequate. Because of the great length of the conduits and the fact that they were tapped along their whole course, only minimum quantities of water at greatly reduced pressure reached the extremities of the network. To remedy this inconvenience, the first idea that presented itself to our mind was to

increase the capacity of the station and to establish new lines of conduits of large diameter. But this solution would have led to enormous expenditures and would not have furnished sufficient improvement, because all the supplementary quantities of water sent into the network would have been absorbed along the way and would not have reached the periphery of the territory served in sufficient quantity.

That is why we were led to the following arrangement, which is much more efficient and at the same time more economical: to let the central pumping station function as in the past and to strengthen distribution by establishing auxiliary stations situated on the periphery of the network, each possessing its independent supply. These stations will boost the pressure at the points themselves or in proximity to them where the pressure is insufficient; in this fashion, since the water will have to travel much shorter distances in the conduits, the pressure drops will be reduced considerably.

With this idea in mind, two auxiliary stations were constructed in 1923 and 1929 on the two shores of the lake in regions near the limits of the network (Fig. 1). It was a simple matter to turn to the lake to create new points of supply. These two stations were placed, one at Pointe-a-la-Bise, on the left bank of the lake, 3¾ miles from Geneva, the other at Versoix, on the right bank, 5 miles from Geneva. They are identical in capacity: each includes a 250-h.p. motor-driven centrifugal pump which discharges the water directly into the network at a rate of about 1 200 g.p.m. Each takes suction from the lake. The intake of the Pointe-a-la-Bise station is situated 2 620 ft. from shore at a depth of 89 ft.; that of the Versoix station 1 970 ft. from shore at a depth of 131 ft. The water flows to the pumps through 16-in. steel pipes laid on the bottom of the lake.

These two stations met expectations perfectly and did away with the lack of pressure in the districts served by them. For this reason, it was decided to pursue, in the same way, the establishment of new stations in other parts of the territory supplied. But in the districts at some distance from the lake, there could be no question of taking water from the lake, and it became necessary to find other sources of supply. The Rhone River, after flowing out of the lake, runs between moraine declivities and does not possess a lower gravel stratum in which it would have been possible to find potable water in sufficiently large quantities. Our explorations, therefore, were directed towards ground waters whose existence was predictable by certain geological indices.

The subsoil of the Geneva region is composed of a "molasse"* base belonging to the end of the tertiary period upon which have been deposited materials of the quarternary period, particularly of the glacial periods which have been recognized for certain as at least two in number. This base of "molasse" presents a very varying profile: at certain points it crops out on the ground, while at others it is cut by deep valleys, the bottom of

* Partially cemented gravel and sand of tertiary age.

which has not been reached by our borings. If one could, therefore, reach one of these valleys that was filled with gravels of quarternary glacial origin and that communicated with a supply basin situated upstream, these gravels would probably be water-bearing, and one would find a stream of ground water of sufficiently great capacity. Borings were made to this end in 1928 and 1929 at Soral, a place 6¼ miles southwest of Geneva, and the water-bearing stratum was actually encountered at a depth of 192 ft. Pumping tests showed that a continuous yield of 800 to 1 200 g.p.m. could be ob-

FIG. 2.— WELL AT SORAL, DURING PUMPING TEST.

tained from a single well at all seasons of the year (Fig. 2). After reaching this result a permanent well was constructed and an auxiliary station installed with a deep well pump driven directly by a 250-h.p. electric motor with vertical shaft (Fig. 3). The auxiliary station at Soral was placed in regular service in 1932.

Analysis of this ground water showed the following values:

	Parts per million.
Total solids	305
Fixed solids	245
Oxygen consumed	1.7
Alkalinity	24.7
Free ammonia	absent
Nitrites	absent
Nitrates	trace
Sulphates	trace
Chlorides	5

This water is harder than that of the lake. Its temperature is 50.5° F.

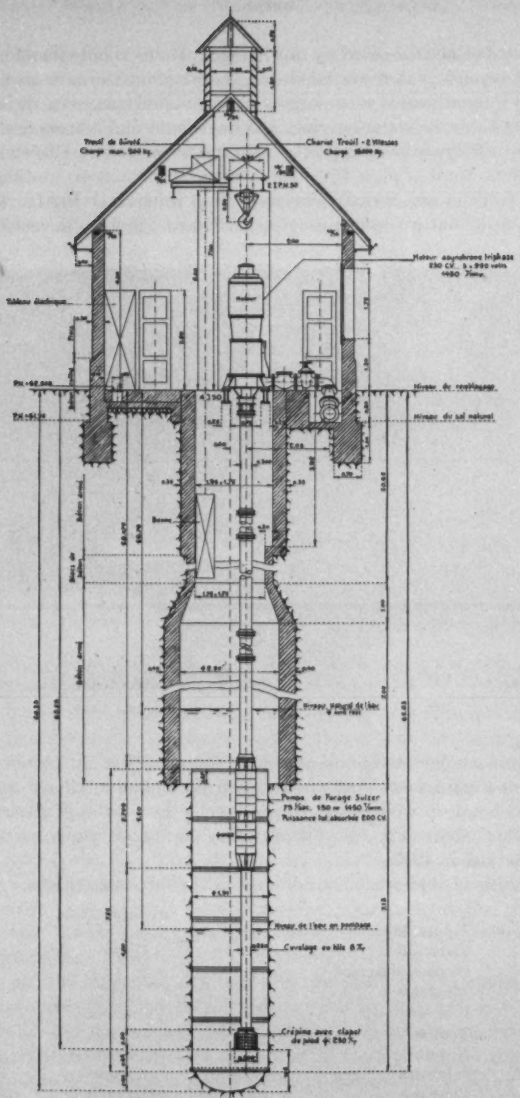

FIG. 3.— AUXILIARY PUMPING STATION AT SORAL.

The success of the exploration undertaken to find ground water at Soral, combined with other geological indices, confirmed the existence of an underground stream of water of great capacity originating in the basin of the Arve, a river that descends from the Mont-Blanc range and joins the Rhone River a short distance below its outlet from the lake. Thence forward the indicated procedure was to turn to this stream to find the amounts of water of which we had need. That is how a new well was sunk at Saconnex-d'Arve, a place south of Geneva, and furnished the necessary supply for a new auxiliary station. This well encountered water at a depth of 152 ft.; the amount of water it can supply is the same as at Soral, namely 1 200 g.p.m. The station, of the same construction and capacity as that at Soral, was placed in regular service in 1934 and happily completes our system of supply.

Later, as demands increase, recourse can again be taken to the subterranean stream in question and new wells established in the proximity of other points in the network. With this arrangement, and thanks to the utilization of ground water, the central station supplied with lake water is now surrounded by a quadrilateral of secondary stations,— a quadrilateral that could become a polygon if one continued along the same lines of development. These stations create supplementary centers of supply at different points in the distribution system. The service pressures are thus much better maintained than if only one central station furnished the supply, no matter how powerful that station. It has been possible in this manner to assure service pressures that are adequate to the extreme portions of the distribution network, which was the end to be attained, and to do away with deficiencies in water which were produced particularly in certain distant regions and which were caused by the excessive length of the distributing lines from the central station.

As to the amount of water available, the following daily capacities may be recorded:

Source	Station.	Capacity — g.p.d.
Lake Water	Coulouvreniere	23 770 000
	Point-a-la-Bise	1 585 000
	Versoix	1 585 000
Ground water	Soral	1 585 000
	Saconnex d'Arve	1 585 000
	Total	30 110 000

This total, which is a maximum, corresponds to a daily consumption of 200 g.p.d. per capita. It could easily be increased, in case of need, by making further use of ground water.

JOINT USE OF SERVICE TRENCHES FOR DIFFERENT UTILITIES.

BY LEON A. GOODALE.*

[*Read September 21, 1934.*]

The subject which has been assigned to me suggests that a new deal is contemplated in the joint use of service trenches. The title possesses a certain attraction and extends the hope that coöperative endeavor is to supplant independent effort. The ideal is alluring but the practical application of the theory seems to be beset with so many obstacles that its ultimate value is questionable. In fact, the proposition reminds me of the anecdote told of one of our presidents who had just returned from church services. His wife asked what the subject of the pastor's sermon was. Mr. Coolidge answered, "Sin." She insisted that he elucidate. The short and simple answer was, "He was against it." That represents my attitude on this subject.

It should be admitted that my objections are based on the practical conditions which we encounter in Worcester. The Heart of the Commonwealth might be used as a representative New England City and naturally is the one with which we are most familiar.

The utilities which are commonly installed to serve property are water, sewer, gas, electricity and telephone. Worcester Ordinances make property owners responsible for the cost and maintenance of all water pipe and fixture installations on their property up to and including the meter. This work, however, must be done by the water department who thus becomes responsible party for its care. The courts have ruled that if the pipe is improperly installed or the water department fails to repair it when it knows the service to be in a precarious condition, then the water department is liable for any damage which may result. Thus, the duty and obligation of our department is definitely established and it does not seem possible that this responsibility could be transferred or shared by others on a copartnership basis.

These questions naturally arise. Who is to be in charge of the general trench? Who is to determine the definite location of each installation? Who is to exercise the final decision in case of dispute?

We believe that there is but one who is qualified to pass judgment on water-supply connections and that one is a water-works official. He knows that the water pipe leaves the main in the street with a covering of from four to five feet and continues to the point of delivery at about the same uniform depth. He realizes that the safest results are obtained by laying that pipe on firm, natural earth without permitting it to be installed on

*Water Commissioner and Registrar, Worcester, Mass.

uncertain fills. Naturally, he objects to its being in the same trench with a sewer which may be several feet below the pipe at the street line in order to meet the grade of the sewer. Likewise, he should resent having other pipes installed practically over or around the service pipe. Such installations can only result in seriously retarding, if not preventing, the repairs which will some day be necessary.

These statements should not be construed as opposition or objection to the use of a common trench when conditions are favorable and suitable for such use. Frequently, we do lay service pipe in such a trench with other utilities, but we never agree to do it until our supervising foreman has visited the particular location, examined the excavation and ascertained that conditions are satisfactory for installing water pipe.

We believe that the first and chief requisite is that the alignment and grade of the sewer connection must run substantially parallel to the water pipe. This condition seldom obtains, yet, we regard it as vital that there shall be no undermining or unstable filling below the water pipe.

We may be conceited, but we feel that our own water department is about the only construction group in Worcester who will make sufficient effort on back-fills to prevent substantial settlement. This accounts, in part at least, for our unfavorable reaction to joint responsibility. We feel able to install water pipes in a practical, substantial way with minimum excavation in a trench refilled so compactly that scarcely any settlement takes place. We desire no copartnership with a sewer contractor whose responsibility ends when the sewer is installed or with public utility organizations who may or may not be in a coöperative mood.

We shall mention three cases where effort has been made in our city during recent years to use joint trenches with what we believe to be typical results.

A filling station had installed a sewer at considerable depth on its property about ten years ago and then requested that the water pipe be placed in the same trench. It was thought that this could be safely accomplished by shelving the original trench at the proposed grade of the water pipe. This may seem simple, but the facts are that the pipe has already developed leaks at four different times and the department has had to go back to make repairs. We believe this is the usual result when short-cut methods are substituted for sound construction principles.

Recently, one of our enterprising contractors constructed a house on a knoll about eighty feet from the street line. It is to be sold as soon as possible so it is not strange if hasty methods of construction were resorted to. A steam shovel excavated an irregular trench varying from ten to fifteen feet in width from the street line up to the front of the house. This was an economy measure to provide a service trench for the joint occupancy of the different utilities. It looked more like the jagged holes of the shell-torn trenches of "No Man's Land" than anything else. However, there was still enough solid foundation left so that we were able to dress it

up and install our service pipe. We foresee the careless manner in which that mammoth trench will be refilled and know that the ultimate owner will probably criticise the water department for poor construction methods. It is not difficult to visualize the gully which must inevitably follow and thus seriously mar the appearance of the lawn in front of this house which is situated in a modern and progressive neighborhood.

We have had one notable test of the practical efficiency of joint occupancy which we take satisfaction in relating. About four years ago, the city decided to erect a new and costly Junior High School building in a section of our city. It was located some distance from the street on a lot with considerable out-cropping ledge. In fact, so much ledge was encountered that it was decided to blast out a common trench for joint use of the various utilities. It is only fair to add that this seemed entirely feasible if it could be accomplished in a proper manner. The work was being done by contract, for and under the constant supervision of the public buildings department. It may not be necessary to mention that there are all kinds of contractors but it is certain that there is no more assurance that they will be kept in their places when working on public projects than when engaged in private enterprises. The result was that when the so-called trench was completed, it was anything but a suitable place in which to install a water pipe, unless the cost of careful refilling would exceed the usual expenditure. The problem was rather a difficult one since we did not wish to appear to refuse to join this modern and progressive way of coöperate effort. Still, we were certain that it was not a suitable foundation and we had no intention of laying a pipe line in the unstable trench, with the obligation of maintaining it afterward. We then decided to take the position that the run to the building was so far that the meter should be installed in a pit at the sidewalk. The water department's responsibility ends at the meter, so we thus evaded the question of common occupancy and with some effort at diplomacy, suggested that the general contractor could probably rush in the rest of the line cheaper than the water department. He did, but when the water was turned on, such serious leakage developed that the water department was called back to repair the contractor's effort. Incidentally, the public buildings officials asserted that they did not want any more experiments on their supply lines. Our final comment on this case is that our meter is still at the street line recording any large or small leaks which may develop on that particular supply.

In closing, we should add that while we have generally criticized joint occupancy unfavorably, we believe that it may be used with success in many instances if the entire matter can be determined and handled by the water works officials who should retain sole and absolute authority in the matter of water-service installation.

This statement is not intended to imply that any water works official is seeking general authority regarding Joint Service Trenches or that this

will be granted. It is offered as the only safe way in our opinion if the scheme is to be universally recommended.

Discussion.

D. A. Heffernan.* I am heartily in accord with what has been done at Worcester. At Milton we have to get a permit for all installations from the Selectmen. The Town Engineer represents the Selectmen in this matter and is also Superintendent of Streets. We have to pay $2.50 a square yard for the paving on a macadam road and $1.75 on a dirt road.

The idea of the Selectmen is to grant permits for only one opening. The gas pipe is laid on one side, the sewer pipe in the center of the trench and the water on the other side, on a shelf. If the excavation is in hardpan or ledge, I have no objection. If ledge is encountered and we could save money by joint occupancy of the trench, we would be glad to do it.

The sewer is not always laid straight. I insist upon the water pipe running in a straight line into the front of the house. In some cases the sewer department gives permission to cut out a connection so that the trench will be at right angles with the street line. If a wire is installed, permission is sometimes given to a contractor to install it in the same trench. We have had difficulties as to who was responsible for the trench after the work was completed.

We had a case in one installation a year or so ago, on a joint installation, where there was a settlement of trench causing damage to an automobile. I told the police department that the water department would not take any responsibility in connection with that trench. Some damages were paid as a result, but not by the water department.

Where water and sewer departments are under the same management, proper provision can be made for joint installations.

Francis H. Kingsbury.† The Department of Health recently had a call from a local board of health. It seemed that there had been a leak in a sewer pipe which had polluted the ground, and through this ground a service pipe trench had been dug. The board was concerned to know whether, in the installation of the service pipe, the service had been polluted from the ground. Fortunately in that case we found from bacterial examination that the water was all right at the time we got there, but we didn't know what it might have been at some other time. That is one phase of the matter that has occurred to me,—the possibility of pollution of a water supply in some way if a water pipe has to be repaired in a joint trench in which the sewer may have leaked.

*Milton, Mass. †Massachusetts State Department of Health.

EMERGENCY WORK OF THE DIVISION OF SANITATION DURING THE NEW YORK STATE FLOOD OF 1935.

BY ANSELMO F. DAPPERT.*

[*Read September 17, 1935*]

New York State's first major disaster and the events which transpired following it, are receding into the past. Now only the physical scars of this great flood remain although it will be many years before some of these are obliterated.

Before the passage of time completely submerges this experience in the oblivion of forgotten events it is desirable that some record be made for posterity. There may be future floods and out of this story may come some suggestions that will prove helpful to sanitary engineers a generation hence. The story will never be told in its entirety. The part which engineers of the State Department of Health played in this emergency is only a small fraction of the total effort exerted in behalf of a stricken people, and even this cannot be told adequately. To the entire engineering staff of the Department the flood emergency offered an opportunity to demonstrate how the staff could respond and render service in a time of distress, and the only claim made is that to the point of physical and mental exhaustion every effort humanly possible was exerted to protect the public health.

The threatened perils to health existent at the time did not materialize. No epidemics of disease followed in the wake of this catastrophe. As a matter of fact health conditions throughout the flooded area were notably better in July and August 1935 than for the corresponding period in 1934. This record has been the subject of much favorable comment, and regardless of the extent to which the engineers may have been responsible, there is satisfaction in recalling that this condition was in reality the single definite objective toward which they worked.

In time of disaster general concern grips the people; fears are accentuated, and situations are viewed with alarm. At this juncture it is fitting to inquire into the reactions at the time and to weigh them in the balance of a calm judgment. Were there real dangers to the public health? Were conditions created favorable to outbreaks of epidemic proportions? Frankly from the beginning those fears were entertained, and it was not until 21 days after the flood, notwithstanding the fact that the efforts had been as prompt and effective as possible, that there was complete reassurance. Fears were engendered in the first instance by lack of knowledge as to what had happened.

*Principal Sanitary Engineer, New York State Department of Health.

From the beginning it was appreciated that, as is true in any disaster, local authorities in stricken communities may suffer from "disaster shock." There is a time when the local health officer or the water superintendent for example may be dazed or pre-occupied with other matters which take on exaggerated import at the moment so that he fails to "see the forest because of the trees." Further, as is true of all disasters, there must naturally be some lapse of time before the details are known to the outside world. Fears were somewhat accentuated when some of these details were ascertained. There is always danger of an epidemic when public water supplies are subjected to serious contamination by polluted flood waters. Favorable conditions for transmission of waterborne disease always exist when simultaneous flooding of private and public wells, privies, cesspools and sewage treatment plants occurs. These conditions and several others did at one time or another exist in the affected area. Sewage polluted water did enter several municipal water systems. In some instances local water authorities under stress of the emergency did fail to take precautions that would have been a matter of routine under normal conditions. Hundreds of private wells were flooded with sewage polluted waters. In view of the wide area affected, the large number of communities involved and the large population that was suddenly forced to resort to water supplies of unsafe or questionable quality, it was almost too much to hope for the favorable record that was attained. No single case of illness occurred in the entire region which could be attributed to a polluted water supply, either private or municipal.

The excessive rainfall preceding and the appalling damage resulting from this flood are probably the striking features that will be most remembered. The man-hours of flood relief activity have already been taken for granted and somewhat forgotten.

Causes of Flood. The peculiar meterological conditions that combined to make this flood a reality are an interesting part of the story. They cannot here be described in detail but in brief the stage was set when on July 6, after a rather sluggish passage northeasterly across United States and Canada, an immense low-pressure area was deflected, by a cold air barrier moving southward, southeasterly across the Great Lakes, so that it centered over New York State. Three general air movements were involved: (1) the passage of a "low" eastward across Canada, beginning June 28 over Alberta, crossing Hudson Bay on July 4, and passing to the Atlantic Ocean on July 5, (2) the passage of an immense "low" area northeasterly across the United States from Nevada beginning July 3, its merging with another "low" area moving southeasterly across Montana, over Bismarck, S. D., on July 4 and deflection of the movement of the combined "lows" southeastward along the northern shores of the Great Lakes on July 5 and 6, by the cold air barrier that had moved in following the eastward passage of the Alberta "low," (3) the passage of another "low" area beginning July 7 over Atlanta, Ga., northeasterly along the Atlantic Coast. The "low" area centered over Cortland, N. Y. and was held practically stationary by the effective cold air

barrier. An explosion of continuous and severe thunderstorms occurred resulting in the cloud bursts which took place on July 7 and 8. Apparently new rainfall records were registered. Unofficial reports gave rainfalls in excess of 8 in. in 24 hours and totalling nearly 15 in. over a three-day period at some stations. The area affected by this heavy rainfall extended roughly from the Adirondacks to Pennsylvania and from the Catskills to the Alleghenies.

Damage was naturally more spectacular in the hilly regions. In many places turf and soil were washed out to bed rock almost on the very top of hills. The flood run-off poured down steep slopes and narrow valleys, raising rivulets to raging torrents carrying with them trees, bridges, buildings and other obstructions. In many places, where only shallow roadside gutters had previously existed, deep gorges now remain. Dams along the streams gave way, adding to the impact of the flood. Flat lands at the lower ends of these small valleys were buried with rock and débris, in some cases to depths of ten feet. In some of the villages, cars parked along streets were entirely buried with rock. Thousands of acres of fertile farm lands were destroyed. Only in the flat valleys as at Hornell and Binghamton did velocity of waters diminish sufficiently to produce the typical condition of inundation. In these areas the receding waters left a trail of damaged houses with basements flooded and floors covered with mud and silt. Houses were submerged in many places to attic floors.

Damage to Public Water Supplies. The fury of the flood can be described somewhat by relating briefly the damage which a few of the public water supplies sustained. At *Delhi*, the filter plant was partially washed away. The 80 000-gal. settling basin was floated 1 500 ft. down stream. At *Walton*, the East Brook emergency pumping station, together with pipe lines at stream crossings within the village were washed out. At *Otego*, a washout in the main supply line left the village temporarily without water. Serious washouts occurred in the distributing systems of *Lisle* and *Whitney Point*, which were among the most severely stricken communities in the flood area. At *Greene* and *Oxford*, main supply lines leading to storage reservoirs were washed out. At *Newark Valley*, the pipe line crossing Owego Creek was washed away. The small supply line at *Richford* was washed out in many places. Wells of the *Hillcrest Water District* and at *Addison*, *Painted Post* and *Owego* were flooded to depths of several feet. The sewage treatment plants at *Corning* and *Ithaca* were submerged. At *Marathon*, the main supply line to the village was washed out. The spring sources of supply at *Interlaken* were flooded. At *Cincinnatus*, lateral washouts occurred. At *Hornell*, the lower reservoir dam gave way, completely wrecking the two supply mains over a length of two miles; numerous breaks occurred also within the city. At *Binghamton*, main supply lines over 2 500 ft. long laid in the bed of the river were destroyed. In addition the Susquehanna River at Binghamton under the influence of the flood coming down the Chenango River reversed its flow causing grossly polluted water to pass upstream over the city's water

supply intake. Washouts occurred at *Bath and Hammondsport*. At Hammondsport, flood waters in the lake put one of the pump motors out of commission, and a further rise of 1 to 2 inches would have made it impossible to pump any water. Hammondsport was one of the communities that was virtually buried with rock, hundreds of tons being washed into streets and over yards and around houses to depths reaching 8 to 10 ft. At *Arkport*, the spring supply was entirely buried with rock and the main supply line between the collecting reservoir and village washed out. This line had originally been laid along a highway leading to the village. After the flood,

FIG. 1.—WASHOUT OF MAIN WATER SUPPLY LINE AT ARKPORT, N. Y.
Spring collecting basin at upper right.

only a portion of the macadam section of the road remained with a deep gorge along side with fragments of the pipe line in the embankment suspended fifteen to twenty feet above the bottom of the gorge. At *Watkins Glen*, due to numerous breaks which had occurred in the distributing system, it was impossible to maintain pressures. Water lines were filled with mud and silt. At *Montour Falls*, the main supply line leading from the filter plant was washed out. Washouts occurred at *Trumansburg* and several other places. Trumansburg was another community that was particularly hard hit. A considerable portion of the business section of the village was washed away by the raging flood waters. Damage of a proportionate nature occurred also in the smaller communities that were not served by public water supplies.

Emergency Organization. It was a matter generally of about 48 to 72 hours before it was possible for Department engineers to complete their check on all the public water supplies throughout the area which had been seriously affected. Hundreds of bridge and highway washouts had occurred making travel very difficult and uncertain. Some communities were com-

pletely isolated for a day or more. Telephone service had been disrupted, and news was slow in reaching the Department.

The excessive rainfall which was responsible for the flood occurred on Sunday, July 7, and most of the damage was done late Sunday night and early Monday morning, followed by more rains and more washouts on Tuesday. First reports to the Department filtered in on Monday afternoon, and by Tuesday morning it was fully appreciated that the State was in the throes of a major disaster.

Several months earlier District Engineers had been established throughout the State, five of whom were in the area affected. These engineers were on duty from the beginning of the emergency. District State Health Officers with nursing staffs were also distributed throughout the area. With this organization in the field supplementing the work of local health and water authorities, the Department was fairly well prepared and did render effective first aid to stricken communities. This field force was rapidly expanded by the assignment of engineers and nurses, from other districts which had not been affected and from the Central office. The exodus began on Monday afternoon, at a time when it was impossible to reach some of the communities, and was practically completed on Tuesday. By Tuesday night the seventeen Department engineers in the field had been able for the most part to check the public water supplies in the most severely stricken communities and take the proper steps to assure the restoration of water service and the delivery of safe water. On Wednesday, the writer became the last of the available staff to take to the field for flood duty, after having until this time been occupied with assisting in the administration of the work from the Central Office, which was a necessary, though less dramatic, feature of the service.

The organization of the field forces and their distribution through the area was simple and effective. Engineers Bates and Bernhardt were rushed from Buffalo to Hornell Monday afternoon to take care of Steuben, Livingston and the eastern part of Allegany Counties. Engineer Riley was stationed at Ithaca to serve Tompkins County. Engineer Wagenhals from Syracuse was assigned immediately for service in Cortland, Cayuga and Seneca Counties. Engineer Holdredge at Oneonta was already on duty at Otsego, Schoharie and Delaware Counties. Engineer Larkin at Middletown was rushed to Walton, and Engineer Bennett from the same office was available for service in Ulster County. Engineer Allen was assigned to Binghamton to supervise and coördinate the work in Broome, Chemung, Otego, Chenango and Tioga Counties and to assist him were assigned Engineers Cox, Kerslake and Zollner. Engineer Erickson was assigned to assist in Delaware County and later to Binghamton to assist in that area. Engineer Agar assisted by Engineers Schermerhorn of the Central Office and Kelly from the Division of Laboratories and Research was dispatched to take charge of the work at Watkins Glen and in Schuyler and Yates Counties. Engineer Schreiner at Ticonderoga was immediately available

for service in Washington and adjoining counties. Engineer Thomson at Amsterdam was assigned to look after Fulton and Montgomery Counties. With some minor adjustments and reassignments, this was the organization and these were the men who bore the brunt of the Division's responsibilities in the flood area which embraced all or parts of twenty-four counties. Excellent liason was maintained between field engineers and District offices and the Central Office. Frequent checks were made on the progress of work in each locality. It was possible to exchange information, deliver instructions and secure quick action on all matters requiring attention.

Nature of Emergency Water Supply Work. It is easily possible to summarize in brief order the general plan of the work, but it is impossible to give an adequate conception of what this work actually involved, the problems which developed and the many intricate and interesting details of the control measures which were applied. In the matter of checking over public water supplies alone and rendering emergency service in connection therewith, it is surprising to note that by the end of the third day following the flood and in spite of difficult travelling conditions the field engineers had checked over the conditions of 93 public water supplies and had rendered aid in the case of 42 which had been damaged or washed out.

The protection to public water supplies, restoration of normal water service, services in connection with water supply emergencies—this was the first order of business. Washouts, many of them severe and resulting in the failure of water service had occurred in 19 instances. The flooding of municipal wells and springs by high waters necessitating emergency measures had occurred in 23 communities, and in several the circumstances were such as to give rise to grave concern. Numerous breaks in water lines allowing the entrance of mud, silt and polluted water added to the public health hazards in most of the affected communities. To meet the public need and alleviate the dangers, it was necessary to install or make arrangements for the installation of portable emergency chlorinators and emergency hypochlorite treatment plants in 16 communities. Many of these were installed by Department engineers. Existing chlorination and water treatment plants were checked and rechecked, and no opportunity was overlooked to assure the delivery of safe water and to render aid of any kind. The work was done so thoroughly that by the end of the third day following the flood, reports from the field engineers received at Central Office gave assurance that there would be no epidemics attributable to infections of public water supplies acquired from that day on. It was clearly recognized, however, that real dangers had existed during the first two days of the emergency, and the fears of an epidemic were not completely dispelled until sufficient time had passed to carry beyond the possible 21-day incubation period for typhoid fever. The absence of diarrhoea and gastro-enteritis, however, gave some indication on the third day following the flood that no particular difficulties were to be expected.

The wide gap between the creation of the definite health hazards through the failure and flooding of municipal water supplies and private wells and the application of proper control measures was effectively bridged by taking full advantage of the general concern that prevailed during the first few hours of the emergency. Warnings were issued immediately and repeatedly over the radio and through the press to boil all drinking water. These warnings were issued by the Governor, by the State Commissioner of Health, and by local Health Officers, and the cry was taken up by lay persons in the affected areas and rebroadcast by word of mouth between neighbors and friends. It is amazing that these warnings could have been so effective. It is frankly admitted that the matter of boiling water was overdone. In several communities, "boil" orders were issued when subsequent checks on the public supplies showed that throughout the period the municipal water had been of safe sanitary quality. But the error was on the side of safety. Checks made throughout all counties of the flood area at the time indicated that these warnings were being taken seriously, and as a consequence few people in reality were exposed to the dangers of drinking contaminated water. The effective response given by the inhabitants of the flooded areas to the warnings thus issued marked the first and most important barrier set up to protect the people against disease.

It was the alertness of local health officers in the first instance that made these warnings effective. Trained over a period of years to be on the lookout for conditions of emergency, the local health officers almost without exception responded immediately to the situation and employed every available means of communication to inform the residents promptly as to the necessity of boiling their drinking water. The warnings issued some hours later through press dispatches and over the radio by the State Department of Health and other central agencies of State Government added weight to the warnings already generally issued by the local health officers and served to keep the people keyed to observance of the practice until normal conditions could be restored.

Treatment of Private Supplies. Public water supplies having been given the attention and service which their importance merited, work was then directed toward the disinfection of private wells which had been affected by the flood. The State Commissioner of Health secured authorization from the Temporary Emergency Relief Administration for a state-wide project designed to make this possible. It became the function of the engineers to organize, supervise and carry on this work, which was started on the third day and practically completed on the tenth day following the flood. This work was started first in the small hamlets and centers of population and then extended into the farm sections. In some sections, the work was carried on with personnel supplied by the Civilian Conservation Corps and the U. S. Soil Erosion Service. About 10 000 private wells were treated with strong solutions of chloride of lime. Few, if any, private wells throughout the wide flood region were missed. The work was accomplished for the

most part by numerous truck details comprising crews of 6 to 8 men who worked simultaneously in the various valleys and sections as directed by Department engineers. These crews were thoroughly instructed as to procedures and there was no particular difficulty in having the work carried on efficiently, intelligently and completely.

Notwithstanding questions which might be raised as to the real value of these efforts, it is believed that they were essential. Even in the case of driven wells, where there is some doubt as to the efficiency of such treatment because of the difficulty of securing penetration of the chlorine solution into the water-bearing stratum, it is felt that the energy expended was worth while. The program had been widely publicized, and it was found that the residents generally were anticipating visits from these disinfecting details. It served to prolong the period during which time the residents would seriously adhere to the policy of boiling their drinking water. In many cases the treatments were effective in eliminating contamination introduced at the time the wells were flooded. The only real danger in the program was that it might develop a false sense of security in the minds of the owners with respect to their individual drinking water supplies. A single disinfecting treatment of a well subject to more or less continuous pollution would be of value only as long as residual chlorine persisted, and in the case of driven wells the effectiveness of the treatment was somewhat questionable. These draw-backs were appreciated from the beginning, and the program was undertaken as much for the purpose of educating residents as to fundamental requirements for safe well supplies as it was for their actual treatment. Many supplies were so located with respect to sources of pollution as to be unsafe for use under any circumstances. The disinfecting details were given a rudimentary knowledge of well sanitation in advance of their work. The men employed on this work were intelligent and were selected with these thoughts in mind. The dangers of nearby sources of pollution were pointed out to the owners of many wells. In some areas, placards were placed on wells denoting that the water was unsafe or unfit to use without boiling. The purpose of the well disinfection program was carefully explained and the limitations of the work made plain. The psychological effect of this work upon people undergoing the strain of a flood emergency is worthy of serious consideration. The visitation of premises for the purpose of disinfecting private wells gave residents, at a time when most needed, assurance that no opportunity was being overlooked in the interests of their health and provided an opportunity of driving home lessons in sanitation that will have permanent values. Many of the well-disinfecting details in connection with their work, were also employed in ascertaining cases of illness, accidents and relief needs in families. This procedure greatly facilitated the functioning of other agencies.

General Sanitation. Emergency work in connection with public water supplies and in connection with the disinfection of private well supplies were the two matters concerning which the field engineers were given

definite instructions. Assignment to flood relief duty, however, was with the understanding that services should be offered in any helpful capacity in furthering the interests of general sanitation and clean-up of the region. The work was to be organized and supervised in detail in sections where needed, and in the areas where exceptional facilities existed for administration of this program or in areas where such work had already been effectively organized, services were to be directed in seeing to it that the essential work was properly carried on. Thus, depending on the particular needs of each community and section the engineers' activities ranged from detailed direction of the work, involving supervision over payrolls and supplies, to assistance of a general and advisory nature. It did not matter how the work was accomplished so long as it was done. It embraced such matters as the following:

(a) Organization and supervision over water delivery services in communities where water supply failures had occurred.
(b) Checking of public eating places to determine extent of compliance with "boil water" warning.
(c) Removal and disposal of dead animals.
(d) Supervision over temporary eating places provided for refugees and workers.
(e) Distribution of chloride of lime for premise disinfection purposes.
(f) Pumping and cleaning out of flooded houses and basements.
(g) Disinfection of basements using portable and truck-mounted spray equipment.
(h) Disposal of refuse, débris from homes, and decomposing matter removed from basements.
(i) Sanitary surveys in small hamlets and rural sections and reporting of illness and relief needs.
(j) Liming and oiling of exposed mud flats.
(k) Oiling of streets and calcium chloride applications to control dust.
(l) Reconstruction and building of privies.
(m) Drainage of impounded waters.
(n) Transportation of people to typhoid immunization clinics.
(o) Sanitation of railroad labor camps.
(p) Investigation of nuisance complaints.
(q) Restoration of sewer systems and sewage treatment plants to normal operating conditions.
(r) Supervision over existing and emergency dumps and incinerators.
(s) Limited mosquito control measures in some communities.

It is impossible to catalog completely the variety of services rendered, but the foregoing will serve to illustrate the principal elements of the sanitation program that was carried out generally in most sections of the flood area. At one time more than 5 000 men were employed on these phases of the general, sanitation program.

Coöperating Agencies. Lest the impression has been created that the State Department of Health looked after all these matters to the exclusion of other agencies of Government, it will be well to point out a few outstanding general observations with reference to this flood experience that are clearly recognized by all who rendered service in connection with it. This flood marked perhaps the first time in history when the agencies of

Government were adequate promptly and effectively to administer to the needs of a stricken people in a major disaster. From a health standpoint, the State Department of Health, through its district plan of organization, was fairly well prepared to meet such an emergency, and it was possible to supplement and reinforce this service promptly through assignments of additional personnel from Central Office and other districts. From a supervising standpoint, the force was adequate to prescribe the essential sanitary services and emergency measures which should be carried on, but the Department lacked entirely the man power necessary to translate advice into action. This man power, however, was supplied through both the regular and relief agencies of Government: Department of PublicWorks, Conservation Department, State Police, TERA, Civilian Conservation Corps, Transient Division of TERA, U. S. Soil Conservation Service and various organizations such as the American Legion and Veterans of Foreign Wars. The existence of a relative large disciplined force, as represented by these various agencies and others, who were thrown into the flooded section immediately, makes this disaster relief experience stand out as a classic. At least to some of the engineers whose experience includes service in connection with major disasters which have occurred in other states, there never was an emergency that was met more promptly, handled more efficiently, nor one which occurred at a time when there was proportionately as much labor immediately available for disaster relief purposes. These disciplined forces were employed on every phase of flood relief activity. Their work began with the rescue of people from flooded homes and continued throughout the emergency period in innumerable ways. Some of them are still at work in clearing farm lands of débris and in other rehabilitation tasks. What the Civilian Conservation Corps and the Transient Division of the TERA and other relief forces actually did for the flood sufferers will probably never be recorded in its entirety, but it can certainly be stated that no bodies of men ever applied themselves more energetically and unselfishly to the tasks at hand than did these.

In some places it was found upon arrival that the essential general sanitary relief program had already been well organized and was being efficiently administered. Here it was only necessary for the engineers to coöperate with those who had already assumed the burden of carrying on the work and to act in a general advisory capacity. In other places it was necessary for the Department engineers to assume detailed direction and supervision over all phases of the program. There was the closest of coöperation between the many agencies and especially the state and municipal agencies operating in the area. This orderly condition is attributed to both the unselfish spirit with which everyone connected with the work approached his tasks and to the plan of organization that was conceived and laid down by Governor Lehman. It had been his order that every Department of State Government, which by reason of its interests and nature of its work could be of any help in the flood area, should respond to the fullest extent of its

facilities. The flood area was divided into three general districts, and a representative of the Governor was appointed in each to coördinate the work of the many agencies and departments. Each agency was represented on a Committee which met daily to discuss problems and find ways to meet them. It was across these Committee tables that answers to the problems of the hour were found, and the speed and dispatch and lack of confusion with which the relief work was carried on bears testimony to the wisdom of this temporary organization.

The work of Department engineers and their anxieties in regard to water supplies were very materially lessened by the aid and coöperation which was given by local health officers, local water authorities, operators, superintendents and from outside sources. In the main local health officers and water authorities responded completely and as far as humanly possible to the public water supply emergencies. Some conditions unfortunately were beyond their control, and it was in these situations perhaps that it was possible to render the greatest aid. No story of the flood relief work could be complete without acknowledging in the first place that it was the untiring and prompt work of local health officers and water authorities, superintendents and plant operators, that established the great barrier against the outbreak of epidemic disease.

From outside sources came material assistance also. Milk and oil companies and cities outside of the affected area promptly made equipment and personnel available for the distribution of water in communities where service had been disrupted. Much outside assistance was provided also for such services as cleaning and sprinkling streets, removing débris, pumping out basements and cleaning and repairing damaged water and sewer lines. The American Legion true to its name poured in as a Legion in some of the communities and performed exceptional service.

It is not possible here to acknowledge all the aid that was thus rendered, but outstanding among this help was that which was extended to the Department by Wallace and Tiernan, Inc. This Company offered the services of its entire staff and the loan of as many chlorinators with men to install them as were needed. The Department made immediate use of this service and is grateful to this Company and to the men who were assigned to flood duty for the aid thus given which was urgently needed and extremely valuable at that time.

As an example of the speed with which this Company worked, it is only necessary to point out the services of Engineer Peck who was enroute to Oxford to install a chlorinator within an hour after we had requested his assistance; or at Dundee where Engineer Keirn within twenty-four hours after our request had a permanent chlorinator installation in operation.

Examples of Emergency Sanitation. The brief allusions previously made with reference to damaged water supplies give a rough picture of the extent and magnitude of the damage suffered, but they do not give much hint as to the total effort and energy expended in meeting problems occasioned by

these water supply failures. It is not possible to give these data in detail and all of it by no means is recorded in the files of our Department. However, it is possible to give some account of a few of the experiences that will serve to illustrate the type and general character of the problems encountered.

Delhi. The Department received word on the afternoon of July 8th that the water supply including the filter plant had washed out at Delhi. Our District Engineer could not reach Delhi immediately because the village was isolated by flood waters, but it was barely possible that it could be reached from Albany by a rather circuitous route. An engineer from the Central Office was accordingly dispatched to the village with an emergency chlorinator, and after numerous difficulties he finally reached his destination at 11 P.M. As previously stated, he found a portion of the filter plant washed away and the settling basin 1 500 ft. down stream. Although the reservoir dam had been topped and considerable fill on the down stream side washed out exposing several feet of the main supply line, the reservoir and intake and pipe line were still intact, and untreated water was flowing to the village. The Health Officer had been prompt, however, in issuing the "boil water order," and posters throughout the village had been on conspicuous display for some hours. Before the emergency apparatus could be installed it was necessary to remove a section of the filter building roof which was in danger of collapse. But the chlorinator was finally installed and in operation within 24 hours after the damage had occurred.

Walton. At Walton, most of the village was inundated. Washouts in the distributing system had occurred at stream crossings. A serious fire broke out from an explosion of gasoline floating on the surface of the water in a flooded basement at a time when about half the village was without water service. Upon his arrival, the engineer checked the chlorine treatment as applied to the several sources and found the dosage somewhat inadequate at one plant. This was promptly corrected. Temporary hose lines were laid where this was practicable to provide service to sections which had been isolated by the breaks. The engineer supervised the systematic disinfection of the entire distributing system in the lower area which had been subject to contamination by flood waters, continuing this work until chlorine residuals were obtained at fire hydrants. A detail of laborers from the state Highway Department was obtained, and a water delivery service using 40-quart milk cans was organized to supply water to families in need of such service. By the fourth day following the flood about 90 per cent. of the service had been restored through construction of temporary lines, but it was July 14 before full service was finally restored.

Otego. At Otego, the Department installed an emergency chlorinator to disinfect the distributing system which had been subject to pollution by flood waters due to a break above the village at a creek crossing. Heavy chlorination was continued until chlorine residuals were obtained throughout the system.

Montour Falls. At Montour Falls, assistance was rendered in connection with the installation of an emergency pumping station which had to be used for three days, before repairs could be made to a broken line that had isolated the filter plant. This temporary equipment provided a means of supplying heavily chlorinated muddy water until normal conditions could be restored.

An interesting side light is found in the experience in one community. For some years a by-pass had existed at the filter plant by means of which raw water could be supplied to the village in times of fire. The Department

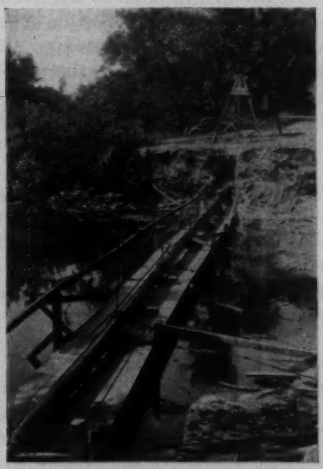

FIG. 2.—TEMPORARY PIPE LINE AT MONTOUR FALLS, N. Y.

had always objected to the existence of this by-pass but had made no headway with local officials in securing its removal. The flood afforded an excellent opportunity to see this closed by-pass in actual operation. It was protected theoretically by two gate valves with a bleeder between them. Both gate valves were found to be leaking, and as the elevation of the clear well was below the elevation of the valves, there was a negative head on the by-pass line allowing raw water to enter the distribution system. The bleeder of course was of no value under these head conditions. The prompt elimination of this by-pass was secured.

In connection with the drinking water delivery arrangement at Montour Falls and Watkins Glen an interesting device was contrived. It consisted of galvanized iron watering tanks of several hundred gallons capacity used commonly on farms. At one end of the trough was a threaded plug to

which a faucet was fitted, thus avoiding the necessity of dipping. The top was kept covered with a sheet. Treated water was transported in milk trucks from Horseheads and Rochester and in disinfected sprinkling wagons from Elmira and upon arrival was given an extra dose of chlorine to safeguard against possible contamination in handling.

Lisle and Whitney Point. No more spectacular situations developed than at Lisle where a main broke and at Whitney Point where a large part of the distribution system was valved off because of a broken hydrant. The water supply of these two communities is furnished by a small water company, the owner of which is a non-resident. The water superintendent lived in the path of the flood from Dudley Brook. His house had been badly damaged, the two automobiles which he used in his work were buried under rocks and mud, and all of the water company's tools, including valves and wrenches, were swept downstream. The water main in Lisle passing under Dudley Brook was broken, leaving Kinney Spring as a source of supply for a small section of Lisle and Cronin Spring as the source of supply for the remaining sections of Lisle and Whitney Point. During the flood, a section of concrete side wall had smashed a fire hydrant, and practically all of the water from Cronin Spring was flowing to waste. In order to shut off the water in the break at Lisle, it was necessary to manufacture an emergency wrench which was accomplished at a local garage. When this break was shut off, about 100 homes were without water. In order to shut off the water at the broken hydrant, it was necessary to close three valves leaving nearly one half of Whitney Point without water. The small reservoir on the system was completely drained. Previous to the arrival of the Department's engineer, the community had been able to get assistance from outside sources, and a chlorinator had been installed on the Cronin Spring supply. The functioning of this equipment was checked throughout the night. However, previous to this time, an emergency well had been put into operation in the basement of a local garage. This well had been flooded to a depth of 15 ft., and the well top was covered with mud. Its use was promptly discontinued as soon as the situation was discovered. By 9 P.M., it was definitely known that all water from Cronin Spring was safe for consumption, but there was an unknown amount of polluted water in some portions of the mains. In the early morning hours, some of the fire hydrants in the section of Whitney Point farthest removed were opened in an effort to drain the polluted well water out of the system. Residual chlorine tests made at daybreak at the ends of the distributing system in both Lisle and Whitney Point showed sufficient chlorine residuals to give assurance that the water was safe. However, a small portion of Lisle and half of Whitney Point were still without service. There was no valve immediately near the broken hydrant. But necessity is the mother of invention. A few blows of a sledge hammer broke up the remaining portion of the hydrant, leaving the hydrant valve stem exposed, and a resounding whack of the hammer drove it down so that later when the water was turned on the leak was effectively stopped. By

noon of the following day adequately chlorinated water was being supplied. With the assistance of the local fire department it was possible to bridge the gap in the broken pipe in Lisle by laying 1 000 ft. of fire hose from one fire hydrant to another, thus bringing into service the previously more or less isolated spring which had not been markedly affected by the storm and the water from which was considered to be of acceptable quality without treatment. A week later, the main break was repaired and the new line disinfected and placed in service.

Marathon. At Marathon, the main leading from the springs to the village had washed out. The District Engineer from Syracuse was able to get there promptly. With some difficulty he was able to arrange for development of an emergency supply and the installation of an emergency chlorinator. A fire pumper was used. The supply gave out in a few days, and a second emergency supply was developed. Repairs were made to the main pipe line, and the line including the reservoir was disinfected before being placed in service. The five individual springs of the regular supply were also treated. The first repairs to the pipe line were of a temporary nature, and later it was necessary to return to use of the emergency sources for a limited period.

Interlaken. At Interlaken, the village springs were flooded, and arrangements were made to cut off the supply and draw upon previously stored water until chlorination could be arranged.

Hornell. Probably no more acute public water supply difficulties developed than at Hornell, and a brief resumé of the conditions in this city may be of interest.

The District State Health Officer who is stationed at Hornell woke up surrounded by flood waters. The water supply reservoir dam was topped about 10 ft. and washed out. The two supply lines to the filter plant, 16 and 20 in. in diameter, were washed out in several places, and repairs were impossible until the waters subsided. The city in addition to being inundated was completely without water. Two engineers were rushed to Hornell from Buffalo district, and after some difficulties they were able to get through. A water delivery service with water obtained from a number of wells located at a local brewery, which had a favorable analytical record, was quickly organized utilizing CCC and Transient Labor. As peddled, instructions were given to boil all the water thus delivered. Delivery was by trucks carrying 40-quart milk cans, and this service was maintained for about 10 days. Some oil trucks were also employed.

Difficulties in bringing in an emergency supply of water at Hornell and making repairs to the damaged municipal supply were particularly severe. By July 9, it had been possible to develop a supply of 450 000 g.p.d. from a source used in the previous year during the drought, by resetting some pumps, restoring power and connecting lines. This water was coagulated and chlorinated but was insufficient in quantity to get service into any sections except in portions of North Hornell. By this time, construction of

an additional supply line from the same emergency source of supply was in progress, and this was in operation two days later raising the available supply to 900 000 g.p.d. Due to previously undetected leaks and breaks in the distribution system at stream crossings within the city, this was still insufficient water to secure service even on the first floors of residences in Hornell. An additional emergency supply was brought into service, raising the total to about 50 per cent. of the normal demand. Three bad leaks were discovered and either repaired or valved off, with the result that on the fifth day following the flood some water was available at first-floor taps in some sections of the city. By the next day, through the further discovery and repair of leaks, the city was getting fairly good service from the emergency sources of

FIG. 3.—WATER SUPPLY RESERVOIR AT HORNELL, N. Y., AFTER FAILURE.

supply. The water was highly turbid, but nevertheless it was water and permitted use of toilets. The filter plant was purposely by-passed so that turbid water would be delivered through the system until an adequate supply could be developed, as the fire hazard was extremely serious and every precaution to conserve water was essential. All water delivered, however, was heavily chlorinated at all times.

Many difficulties were experienced making repairs to the damaged supply lines. The 16 in. line was checked and recalked several times, but when placed in service, additional leaks and sags would be discovered, necessitating repairs. This line was, however, finally placed in service on the ninth day after the washout, and filtration of the supply was resumed. Engineers of the Department assumed general charge over the operation of the filter plant and were of service generally to the city engineer in this capacity for several days. Extreme difficulty was experienced in the coagulation of the water. The raw water was extremely turbid and highly buffered. For a time over 5 grains of alum per gallon were required to effect proper

coagulation. Fortunately the sanitary sewer system was not greatly injured. It was feared that many of the lines would be badly silted, but only a few minor stoppages occurred, and these were promptly corrected.

Later in the month, heavy rain occurred which nearly resulted in the washout of the temporarily repaired main water supply line. By prompt action, however, 150 TERA laborers were rushed to the scene, and a stone fill was made which averted the catastrophe. To have suffered a second washout at Hornell would have been the straw to break the camel's back. The people's courage had been strained to the breaking point. On the last day that extremely turbid and heavily chlorinated water was distributed through the municipal system as a necessary conservation measure in the interests of fire protection, the general morale of the people had reached a low ebb. The final restoration of the main supply line, permitting the delivery of an adequate quantity of clear filtered water the following day, had strengthened the general morale in a real and tangible way. To have been forced to resume the emergency arrangements of the previous days would indeed have been a calamity. And no one appreciates this more perhaps than the City Engineer of Hornell who spent many sleepless nights and gruelling hours in applying his skill and knowledge to the requirements of the emergency and who suffered most from personal loss in the sudden death, attributable to strain of the emergency, of one of his most dependable and trusted employees in the Water Department.

Conclusion. It is with real satisfaction that the engineers of the Department look back upon this flood experience. Services were freely given and they seem to have been generally appreciated. Governor Lehman in a communication to the Commissioner on July 18th, 1935 said "I should very much like to have the State workers in your Department know of my great appreciation of their services during the flood emergency. Perhaps there is some way in which my expression of appreciation may be made known to the members of your Department. I again want to thank you and your co-workers for the splendid, energetic and unselfish devotion to duty shown by all during the trying period of the flood. I have been greatly gratified to have had very convincing proof that State governmental agencies can act so promptly and so efficiently in an emergency." These orchids were distributed to members of the staff through a special message from Commissioner Parran who said: "The efficiency of an army is determined only by the test of war. The efficiency of any organization similarly can be tested by the way it deals with an emergency. The recent floods provided the emergency which tested the ability of State Health and other State forces to meet a serious menace. So far as I know, this flood was the first instance in which a major disaster of comparable extent was met and handled by the organized forces of Government. The efficiency with which representatives of the Department functioned throughout the flood area has been the subject of favorable comment by the Governor, by other Departments, by local officials, and the public generally. I want to express

my very sincere gratitude to each of you who has contributed to this remarkable record of service." A final bouquet was received from Deputy Commissioner Brooks who added "The various reports indicating that a good job was done came as no surprise. It was expected. The Department had met serious emergencies before — polio in 1916, influenza in 1918 — and its performances have always been creditable. The flood emergency was something new and different, calling for immediate and decisive action. With a minimum of confusion and delay the outfit went to work — The engineers under the command of 'Colonel' Holmquist, bore the brunt of the work from the 'word "go" ' and if there is no greatly increased incidence of typhoid they will be entitled to a big share of the credit."

No experience of this magnitude should be recorded without pointing out a few of the lessons learned and the sufficiency of measures which will prove most effective in future emergencies. The value of the Department's work would have been considerably enhanced by the receipt of prompt appeals for assistance from local authorities and prompt reports from communities as to actual conditions. Some valuable time was lost in ferreting out supplies which were in need of assistance from those which had not been materially affected. In some of the communities where aid was urgently needed, several hours' delay occurred before the Department was aware of the difficulties and the assignment of engineers was correspondingly delayed. This situation can only be corrected by the gradual education of local authorities over a period of years to the point where they will react promptly in the matter of appealing for assistance. It is a situation that may be improved but perhaps never entirely corrected. Future emergencies, therefore, will be characterized by these initial delays, and there will always be a certain definite period following these catastrophes when definite health hazards will exist and when conditions favorable to mass infections will be created.

It is well to recognize these contingencies in advance and barricade against them by issuing promptly general "boil water" warnings, utilizing the press, radio and every available means of publicity. To be effective, the first warnings naturally should be by local health officers as time is of extreme importance. It matters not in times of emergency whether mistakes are made or not, so long as the errors are on the side of safety. Warnings issued a few hours later by central agencies of Government will reinforce and emphasize the appeals already made, will serve to prolong the time during which local residents will seriously adhere to the policy of boiling water and will afford an opportunity for engineers to swarm in over the public supplies and set them in order before the people recover from the general concern.

It is essential to reduce by every hour possible the delay incident to getting engineers to the communities affected. Travel difficulties of an almost insurmountable nature will present themselves, but usually some way will be found to overcome them. It is expected that engineers assigned

to such work will go without sleep until water supplies have been checked and action instituted to assure the delivery of safe water. In communities where water failures have occurred, it is essential from the beginning to organize and supervise the delivery of water from approved sources.

Following any major flood, the work of disinfecting private wells and related activities will form one of the essential elements of the relief program. Flood sufferers have come to expect this service, and regardless of whether or not the efforts are entirely successful, the work affords an excellent opportunity for health education and instruction in matters of sanitation that will have permanent values. The work should be undertaken with its definite limitations in mind, and these limitations should be carefully explained as the work progresses.

In similar emergencies, the public will entertain great fears as to the danger of disease from flooded basements, exposed mud flats, decomposing débris, and the like. Actually, there is little danger in these objectionable and somewhat obnoxious conditions, except possibly in the matter of fly breeding which may be encouraged in the stacks of vegetables and putrescible material removed from basements. Every effort should be made to allay these fears, at the same time giving adequate recognition to the aesthetic objections to such conditions and lending such efforts as are possible to restore premises and streets to a wholesome sanitary condition as rapidly as possible. In this connection, the generous use of lime and chloride of lime is thoroughly justifiable for premise disinfection purposes. In such emergencies, there is a definite need for reassurance to flood sufferers who are under considerable strain that every possible effort is being made to protect their health and add to their comfort. The liming of exposed mud flats, disinfection of basement walls and floors with chloride of lime, liming of piles of débris removed to the curb line, and similar activities which in reality have little specific public health values do have very definite psychological values and should be carried on.

The outstanding lesson learned from the flood perhaps is that there is definite need in New York State for undertaking a comprehensive program of rural sanitation, primarily along educational lines. For many years the Department has sought by every means at its disposal to foster sanitary improvements in rural sections, and no doubt these efforts have been successful. But enough work still remains to justify the expansion of effort in this direction. Facilities of the Department are limited at present, but it is hoped in time that it will be possible to give attention to the problem of sanitation on farms and in small hamlets in proportion to the importance which this work merits.

GATES AND HYDRANTS.

BY THOMAS E. LALLY.*

[*Read September 21, 1934*]

My discussion of the spacing of hydrants and the insertion of gates in old systems is informal. No one would try to tell a meeting of superintendents how they should proceed, or where they should place gates. But I am sure that all superintendents have points in their system at which they would like mightily to install a gate, only they never get the time; or the system is functioning and they do not care to break into the lines; or they are afraid that some big water taker, or some large apartment house with a good vote will make trouble.

In the old Boston system there were many old gates, and many lines in which gates were spaced up to 1 200 or 1 500 ft. apart. In the last 25 or 30 years we have gradually been cutting out these old lines. In most cases the missing gates have been supplied, not by inserting new gates but by putting in larger pipes with gates correctly spaced. For instance, 6- and 8-in. pipes have been replaced by 12- and 16-in. pipes. Only where feeder lines were lacking in gates have gates been cut into the old system.

When the Metropolitan District took over all works outside of the city line we were left the control gates downtown on some of the lines, and we have cut in 36-in. gates and a few 30- and 24-in. gates, but on the whole our problem has been solved, not by inserting gates but by relaying the lines.

On the spacing of the hydrants in Boston, it has been the policy of our department to install them in the congested districts every 250 ft. An endeavor is made to place these hydrants in such position that they do not interfere with doorways, driveways, and big show windows. In residential districts, hydrants are not over 300 ft. apart.

In residential districts we have been up against a new problem in the last few years. We receive the complaint that there is a hydrant in front of the house and that it interferes with constructing a driveway to a garage. Applicants are required to deposit $125 to change the hydrant in front of their door.

To avoid this trouble on new extensions, we endeavor to place hydrants exactly on the lot line projected out to the sidewalk. Then one owner can have no more objection than the next, and either of them can build a driveway to their garage.

On these hydrants we have been forced to put a gate. We hear much of hydrants that do not make a fountain when an automobile hits them. But in the last analysis, if a hydrant gets bumped it has to be put out of commission for a while. Sometimes the hydrant has to be dug out for

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repairs. That does not happen to every hydrant, but it does happen to a lot of them in Boston. That is why it is so important to have hydrants between gates in city blocks. It means that unless the hydrant is gated there is no way to get it out unless the whole line is shut down. If the line is gated a man can be placed at each line gate at the nearest block, and a third man at the hydrant-gate with a wrench. At a signal both gates go down at once, and immediately the third man shuts the gate at the hydrant. When the fountain stops the other men open up. You do not have to notify the people on the line. The gate is not shut down long enough for anybody to find out that the water was shut off.

Due to the prevalence of breaks in hydrants I think all hydrants should be gated, irrespective of the peculiar advantages the hydrants may have in themselves.

One of the primary reasons why gates have been changed in our system is that our system had many two-piece body gates, left-handed threads, and old type gates. All of these have been replaced, and I believe today there are only two large gates in the whole system which are left-handed. All other gates open to the right. We know where the left-handed gates are, and they are marked at the gate.

Discussion.

H. L. Clark.* Do you use a tapping sleeve when you move a hydrant?

Mr. Lally. No. We cut the line and put the branch in. We have used tapping sleeves in some instances where we did not think it advisable to shut the line down. But as a rule the line is cut and the branch leaded in, and the hydrant set up on the new branch.

Mr. Clark. What is your practice on gate boxes? Are most of them in manholes, or not?

Mr. Lally. We have three types. We use a concrete box made in four pieces, with a little platform on the top, on which we set a flanged frame about 17 in. by 14 in. That is what we call our small gate frame. The box is made of slabs of concrete, precast and wired together.

We have another type of box known as a jumbo box. It weighs about 500 lb. It is made in two parts, and is about 14 in. in inside diameter and flares out, much like a funnel, on the bottom. It comes with three threads on the top of the lower part, and the top part, which screws down, is adjustable. It is threaded the whole distance, about 20 in., but there are only about three threads on the lower part.

On the 4-in. gates or smaller we set up a piece of pipe as a rule with a flanged box. We refer to it as a 9-in. by 9-in. flanged frame. The cover is 9- in. square, and a piece of 2-in. pipe comes out through the ground and sticks into this box. We put a cap on it and a cover. We use the box on

*Sanford, Maine.

many of our corporation cocks where there are evidences that we will have to take care of them sometime without digging.

On 16-in. gates and over, there is an oblong frame, which is usually built onto a brick chamber. This oblong frame is about 24-in. by 14-in.

The idea of the so-called jumbo box is that it will hold a lot of tin cans and bricks before it fills up so much that you can't get at the gate nut. In one district the foreman spent a good deal of his time fishing out the stuff that the boys put in the boxes. The engineer in charge suggested, therefore, that we make the box big enough so that it would take a long time to be filled. In connection with smooth-surfaced streets that are cleaned with a street-sweeping machine, there is produced a muck, that never seems to harden or set. This muck is swept into the boxes, and I don't think there is a cover, unless it is the Edison Company's D. C. cover, that will keep that stuff out of any box. Many times we have to pump out the boxes when we wish to operate the gates. Of course we can find the stem through the muck, as it never hardens. But it has to be pumped out in a good many cases.

ROGER G. OAKMAN.* In the case of a hydrant broken by an automobile, what charge do you make against the driver?

MR. LALLY. It costs the man who breaks off the hydrant, if we can catch him, somewhere in the neighborhood of $100.

H. B. COLLINS.† Your remark about the boys dumping tin cans and other rubbish into gate boxes reminds me that in our little town, about twice a year, a member of the water department goes to the different classes of the school, explains the situation in a very elementary way and asks the help of the youngsters in protecting the system. It is surprising what help and information they do bring in about service boxes having their lids off, or being filled up. We try to coöperate with the youngsters and they have certainly done their part too.

SIDNEY S. ANTHONY.‡ You spoke of not using a tapping sleeve or valve in a good many cases. I would like to know if the Boston Water Department has any particular objection to using tapping sleeves or valves.

MR. LALLY. No, there is no objection. I have used one machine on the downtown section, mostly on fire pipes. But in the suburbs there is no reason, except in a few cases, why one cannot shut the line down and put the branch in. We have been trying to get easy curves and want to reduce the friction losses of hydrants. Consequently we mould the valves and the outlets so as to stream-line the water. A tapping sleeve cuts a knife edge out of the side of the pipe and one cannot expect it to function as well as one which has a branch in it. I claim that the tapping machine has its place, where it is necessary, but if you do not have to use a tapping machine, put in a branch that has a good sized curve. That is my position in the matter. The tapping machine is fine; it is almost indispensable in some places downtown where there are high-pressure lines and power plants and boilers.

*Needham, Mass. †Manchester, Mass. ‡Augusta, Maine.

There we can tap in a 4-, 6-, or 8-in. gate without shutting down the line. But where you can conveniently put in a branch, where you have low pressure instead of high, where you can reduce friction loss, I would rather avoid the knife edge and put in a branch.

J. H. READ.* In operating gates we quite often find that they leak through the stem, but on being fully opened they will stop leaking a good many times. Is it your practice to repack these gates, or do you wait until they get to a condition where they have to be repacked?

MR. LALLY. We do not repack them unless we can see the wicking sticking out, or the packing. We have what we call a squeezer; a thin wrench, probably a half inch in diameter, so that a man can tighten down the gland and stop the leak. But we do not dig down and repack unless we can't stop the leak. Sometimes, for the time being, we can find a position where the gate will not leak quite as much as it does when it is way out.

J. P. MILLER.† If a street is to be resurfaced and you have in that street a number of hydrants without any gates on them, would you put gates on all the hydrants before the new surface was laid?

MR. LALLY. Yes, we would. At Boston a list is issued every so often of proposed street surfacings. This is sent to the water and sewer departments and to the electric and gas companies. When it appears, the engineer to whose division it has reference will pull out his plan and say, "We have a couple of hydrants on that street without gates on them, and I guess we had better insert gates."

MR. MILLER. Who pays that expense? Does it come out of the project or out of the water department?

MR. LALLY. Ordinarily it comes out of the water department, as a part of our expense. We are the only income-producing division in the City of Boston.

MR. MILLER. Don't you think that the cost of these changes should come out of the project.

MR. LALLY. I do.

MR. MILLER. We charge it to the project.

HOWARD M. KING. ‡What kind of a gate do you use on hydrants: bell and spigot or bolted?

MR. LALLY. Double bell gates.

MR. KING. In the winter of 1911, I think it was, at Springfield we had about 4½ ft. of frost, and a hydrant kicked off. It travelled about 15 or 20 ft. and wrecked a brick building, an old house with a family living in it. Since then we have always bolted the gates to our hydrants.

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* Manchester, N. H. † North Adams, Mass. ‡Springfield, Mass.

RECENT DEVELOPMENTS IN THE PROVIDENCE WATER WORKS.

BY PHILIP J. HOLTON, JR.*

[*Read September 17, 1935.*]

Recognizing the necessity of making improvements in the distribution system that would prove more adequate with the increased capacity of the new Scituate supply, Commissioner Maguire, in August, 1933, decided upon a comprehensive water-works extension program which would increase the facilities of the distribution system in both the high- and the low-service areas and would afford additional protection in the high-valued fire district.

This plan involved the laying of over 22 miles of pipe, ranging in size from 6 to 26 in., most of which was laid in the cities of Providence and Cranston, with some additions to the system in the towns of North Providence and Johnston. Extensive improvements were made in the low-service system, particularly in the Cranston area to furnish additional capacity for the city of Warwick, which eventually will place increased demands on our system as the growth in that community has been more rapid than in most areas within the district.

In the high-service area, reinforcements were designed not only to afford additional protection in the high-valued fire district, but with the intention of providing the system with sufficient capacity for additional consumption in North Providence and Johnston, which towns also have shown rapid increase since the last census.

In addition to improvements in the high- and low-service systems previously mentioned, 238 dead ends, ranging in size from 6 to 16 in. were eliminated. It was impossible to eliminate all dead ends due to the existence of a number of dead-end streets but, with improved circulation in these areas together with improved water treatment, the number of "red water" complaints should be reduced to a minimum. With the completion of this work it is our intention to obtain periodic analyses of water within these areas to determine the extent of improvement made by this construction.

Previous to our water works-extension program, Bath Street pumping station was the only agency to supply the high-service area. Its suction was obtained from the 48-in. Neutaconkanut low-service line, running from Neutaconkanut Reservoir through the Olneyville section of the city to Bath Street. The high-valued fire district in the center of the city and all high-service areas were entirely dependent upon this single station which obtained its supply from a low-service main. A break in the low-service line or a station breakdown during a fire would jeopardize property in the districts served.

*Superintendent, Scituate Reservoir Division, Providence, R. I.

With the former Bath Street pumping station operating, the capacity of the Neutaconkanut low-service main was naturally reduced to supply the requirements in the high-service area which reached a maximum of 6 m.g.d. The station was equipped with four 3-m.g.d. pumps, two of which were motor operated and two gasoline-engine driven. With all pumps running, the station could deliver water at the rate of 12 m.g.d., of which 2 m.g.d. would go to the daily consumer, leaving 10 m.g.d. to be drawn from the high-pressure fire mains. With all four pumps in operation, Longview Reservoir would simply supply the remainder of the daily demand in the

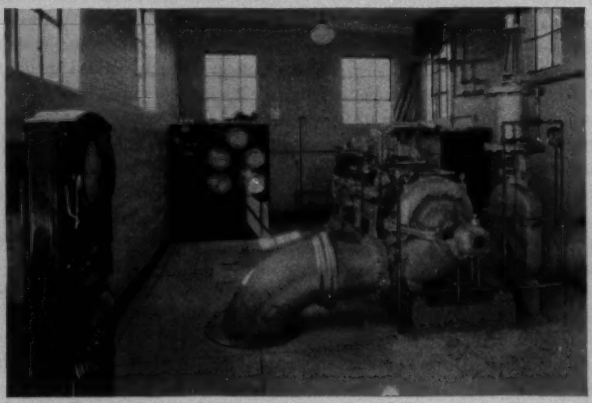

FIG. 1.—GASOLINE-ENGINE DRIVEN PUMP WITH INSTRUMENT BOARD IN BACKGROUND, NEUTACONKANUT PUMPING STATION.

high-service areas which would reach a draft of 4 m.g.d. Under this operating characteristic, the reserve capacity of Longview Reservoir was not available for fire service in the high-valued district of the city. With all pumps at Bath Street pumping station off the line, Longview Reservoir alone could furnish 5 m.g.d. for fire use in the high-valued district in addition to the maximum daily demand.

Under the circumstances, it was decided to maintain Bath Street pumping station as a reserve plant only and to construct another booster station adjacent to Neutaconkanut Reservoir with superior operating characteristics and increased efficiency and capacity incorporated into the design. The new station is equipped with duplicate suction mains and can obtain a supply either from Neutaconkanut Reservoir or the 48-in. main that connects the reservoir to the 60-in. line from Scituate Aqueduct. Neutaconkanut Reservoir has a storage capacity of 42 m. g. d. and sufficient capacity is available for operating the new station even with

a breakdown of the supply main to the reservoir. Using only 25 per cent. of this available storage it will furnish a fire flow of 15 000 g.p.m. over a period of ten hours. The new station will place no demand whatsoever on the low-service system in the high-valued fire district, thus restoring additional capacity at the low-service hydrants. The station can deliver water at the rate of 11½ m.g.d. with a draft of 9½ m.g. available from Longview Reservoir during a fire demand in the high-valued area plus the maximum daily demand in the high-service district.

Originally it was planned to install three motor-driven pumps, but to secure maximum dependability it was decided to install two motor-driven units and one gasoline-engine-driven pump (See Fig. 1). To obtain maximum economy in power costs, due to seasonal demands on the system, one of the motor-driven units has a capacity of 4 m.g.d. and the other 6 m.g.d. The gasoline-engine-driven pump has a normal capacity of 10 m.g.d. and will be used only during heavy fire flow and power failure of the motor-driven units. In providing electrical equipment, every precaution was exercised to secure continuous operation. The local power company agreed to furnish dual feeders from two different sub-stations over independent and separate routes. One feeder is supplied from the Olneyville sub-station, the other from Knightsville sub-station. Automatic switches are provided which will instantly transfer the load from one circuit to the other in case of power failure.

With the new station in operation, the city will effect an appreciable reduction in the cost of power. The annual cost of power for the operation of Bath Street pumping station was approximately $7 200. At first it was planned to maintain the two motor-driven units along with the two gasoline-engine-driven units at Bath Street but the standby charge on the two motor-driven pumps was such that it increased the annual cost of power to $8 800. Under these circumstances it was decided to request the power company to discontinue service at Bath Street pumping station, leaving only the two gasoline-engine-driven pumps for emergency operation. However, the electrical equipment will not be disturbed and the power company claims that in case of extreme emergency the units could be connected up on comparatively short notice. With the discontinuance of service at Bath Street pumping station, the annual cost of power will be approximately $5 900.

Provision having thus been made for the extension and improvement of the distribution system through elimination of dead ends, laying of additional lines and improvement of pumping facilities, attention was then turned to the source of supply. As a step toward the protection and conservation of the city's water supply, this department began in December, 1933, an extensive program of reforestation scheduled over a ten-year period. The supply, although seemingly adequate to meet the city's needs for years to come, is being subjected to increased demands from outside. Parts of Cranston, Warwick, Johnston and North Providence are now tapping our supply, and efforts have been under way for some time to bring about further

extension of our service to these communities. To prepare for such eventuality it is necessary to assure maximum production by protecting the yield from available sources.

Under the reforestation program inaugurated at the end of 1933, new growth is provided for through the planting of selected young stock, and present desirable growth receives protection and assistance through a systematic thinning out of undesirable timber and brush. There is also to be provided a network of roads to give access to the forests in order to facilitate fire fighting and thus curtail fire losses as far as possible. The first part of this program was a large clearing job, which provided for clearing the margins of the main reservoirs of all growth for a distance of 138 ft. The total margin around these reservoirs is about 61 miles. The area to be cleared under this part of the program consists of about 1 020 acres. Additional clearing is to be done over 1 469 acres which in late years have been destroyed by fire. Planting of young evergreens is then started in the newly-cleared areas as well as in all open areas on the property. Existing hardwood stands are thinned out and interplanted with conifers.

Some idea of the scope of this clearing and planting program can be obtained when it is realized that the area owned by the city in Scituate totals 23.1 sq. miles, an area greater by 5 sq. miles than the city of Providence itself. Flowage covers about 7.0 sq. miles of this territory, leaving 16.1 sq. miles to be encompassed in our reforestation program. Under the ten-year schedule, 11 100 acres will be reforested. Thinning and clearing has been completed on about 1 700 acres, leaving 9 400 acres to be done. The planting schedule provides for the setting out of about 16 million trees over the entire area. Planting has been completed on 850 acres, 1 900 000 trees having been set out by our forces to date.

Coincident with the clearing, thinning and planting operations, our forces have been engaged in the construction of fire lanes and access roads, much of this work being done in virgin territory. This construction consists of building access roads leading to the water and a series of belt roads which intersect the access roads, providing a network which makes all portions of the area accessible in case of fire and facilitates the hauling of water to threatened areas. These roads and fire lanes are 40 ft. in width, providing an effective fire stop. This 40 ft. strip is completely cleared and grubbed; gravel is then spread over a 12-ft. width, providing a firm foundation and satisfactory traction for such equipment as may be needed in fighting fires (See Fig. 2). The entire program provides for the construction of 50 miles of these roads. To date 14 miles are in the course of construction.

As another link in the protective chain thrown around the city's water supply, a 100-ft. fire tower was erected during the Spring in the Tunk Hill section of our property. The use of this tower assisted materially in reducing the number of forest fires in this area. The site selected provides observation not only over the entire main reservoir but also of Barden, Westconnaug, Moswansicut reservoirs and the Regulating Reservoir. During the fire

hazard period, an observer was stationed in the tower from 10:00 A.M. to 6:30 P.M. seven days a week and coöperated with the attendants in the State-owned fire towers at Bowen and Chopmist Hills. Over 98 fires were located by the observer, and each forest fire was reported and checked by the local State towers. The installation of this tower was one of the best investments made in conjunction with our forestry program. Last year 440 acres of valuable timber were destroyed by fire on city-owned property, whereas this year less than one acre, located off the Greenville Road adjacent to Moswansicut Reservoir, was destroyed.

FIG. 2.— COMPLETED ACCESS ROAD ON EAST SHORE OF MAIN RESERVOIR NORTH OF ASHLAND CAUSEWAY.

Steps having been taken toward the development of our wooded areas through thinning and planting operations and toward the safeguarding of these areas through provision of access roads, attention was turned toward a ready source of supply to fill our future needs in the reforestation plan. In the initial stages of our reforestation work, it was necessary to purchase great numbers of trees from New England and Canadian nurseries. Difficulty was encountered in getting the type of stock desired for early spring planting. The difficulties involved in the handling and safeguarding of this stock, too, were of no little moment. Speed in handling and setting out had to be exercised to prevent spoilage. Despite efficient work on the part of our forces and the exercising of all possible precautions, losses in handling continued to run high on stock which we purchased from local nurseries. On a schedule of 707 955 trees received, there was an outright loss of 67 534 before the trees were set out on the watershed. The nurseries make some attempt

to offset these poor trees but on the other hand they never include sufficient numbers over the order to reimburse us for the entire loss. Also, most of the nurseries are located in the northern part of New England, with the result that they are unable to dig the trees out of the ground, due to frost, much before the middle or end of April. Under ordinary weather conditions we are able to start our planting program in this territory between the first and fifteenth of March, and the trees should be set out not later than the end of April. With trees available from our own nursery, our planting could

FIG. 3.— GROWTH OF RED PINE AND WHITE SPRUCE IN SEED BEDS AT THE NURSERY.

be completed before the northern nurseries would be able to make shipments, allowing us ample time to take advantage of the heavy spring rains and obtain a high survival of the trees planted. Other factors, too, indicated the feasibility of establishing our own nursery to supply future needs. Accordingly plans were made for the establishment of a nursery and the raising of our own trees. The site selected for the nursery is located off the drainage area below the Main Dam, and contains approximately 20 acres. The ground was prepared this spring for planting of the seed beds, and before the transplant beds are required the turf will be properly prepared for setting out the trees in this area. An area of two acres was set aside for seed beds. Eight seed beds, 165 ft. long and 3½ ft. wide, were prepared. In these were planted something over 1 500 000 white spruce and red pine seeds (See Fig. 3). From present indications the yield from this nursery will be

about 1 500 000 trees in the Spring of 1937. The young stock will then be taken from the seed beds and set out in our adjoining transplant beds. An area of eighteen acres has been set aside for transplant purposes, with a capacity for receiving 2 500 000 young trees.

As a result of the establishment of the nursery and transplant beds we will in the future have production fully ample for our needs. We will eliminate the difficulties hitherto encountered in handling purchased stock and, we hope, reduce our losses to a minimum. In addition to providing for greater ease of handling and eliminating other difficulties previously experienced, the establishment of our nursery should result in substantial savings in the cost of young trees.

As a result of changes in the operating schedule at the Hydro-Electric Station, a record for power production was established for the contract year ending June 30 of this year. The previous record was for the contract year 1933, when, with 62.97 in. of rainfall and 37.32 in. of runoff the plant produced 7 024 900 k.w.h. During that year 15 187 m.g. flowed over the spillway. During the past contract year, the plant was operated to reduce the spillway loss to a minimum. As a result only 155 m.g. went over the spillway, this resulting chiefly from flashboard leakage. The power production totaled 7 102 900 k.w.h. with only 49.11 in. of rainfall and 27.44 in. of runoff. The city received a total of $27 024 from the local power company for power sold to them. Previous to the change in operating schedule, under normal rainfall conditions, the city received only sufficient income from the sale of power to pay the fixed charges on the investment. The new schedule places the plant on a self-liquidating basis which should continue from this date on.

Thus, during the past year and a half, the department has made provision for extending and improving service throughout the district through the laying of additional pipe, the elimination of dead ends and the construction of a more adequate and efficient pumping station adjacent to Neutaconkanut Reservoir. Our extensive reforestation program has been launched, and is well under way. This will prove to be a potent factor in the protection and conservation of our supply as well as a source of revenue in years to come. Finally, the Hydro-Electric Station, heretofore performing a perfunctory service, has been more fully utilized to increase efficiency and make the station self-supporting.

In brief we have, in the past year and a half, fortified our distribution links and protected our source of supply, greatly increasing the value and efficiency of the whole system while effecting numerous economies.

PROVIDENCE WATER TREATMENT.

BY ELWOOD L. BEAN.*

[*Read September 18, 1935.*]

Papers previously published in this JOURNAL† fully describe all phases of the development of the Scituate Supply for Providence, together with operating methods and experiences up to the Fall of 1931. The present paper will present experiences since that time together with supplementary data and will cover the period of 1931 to 1935.

Raw Water. Water has been drawn at all times from the lower intake of the Scituate Reservoir, less than 20 ft. from the bottom and approximately 60 ft. below the surface. This has been done for three principal reasons: (a) to take advantage of the natural coagulants in solution in this lower stratum; (b) to avoid growths of microörganisms in upper water strata; (c) to deliver water of lower temperature to the consumer.

Raw-water characteristics are shown in Fig. 1, indicating wide fluctuations in quality at the various seasons. Some reduction in the iron and manganese content since 1931 might be noted as an indication of greater stability. However, other results are somewhat contradictory to such a conclusion.

Counts of microörganism in the raw water are shown in Fig. 2. Counts on surface water from this reservoir have occasionally been as great as ten times the count on water from near the reservoir bottom, averaging about twice the count. A rather extreme growth of blue-green algae occurred in June of this year when, for a period of a week or ten days, a decided odor prevailed in the vicinity of the main reservoir. These organisms, under the influence of wind and waves, gathered in coves producing beautiful blue-green water. Counts as high as 60 000 of the cyanophyceae (*Anabaena, Cylindrospermum, Clathrocystis*) were obtained. No treatment of the reservoir was necessary since the point of intake was so far below the surface. Only once have microörganisms been present in sufficient numbers to cause distinct trouble in purification. This will be discussed later in relation to tastes and odors.

Average characteristics of the raw water for the fiscal years ending September 30, are shown in Table 1. Reference to Fig. 1 may aid in interpretation of these averages.

Purification. From August 9, 1931 to May, 1932, treatment consisted of the addition of copperas (ferrous sulphate), aëration, lime treatment, mixing, coagulation and sedimentation, filtration, and secondary aëration. In May, 1932, this treatment was modified by chlorination of the copperas

*Chemist, Providence Water Works.

†Vol. 40, 1926, p. 477–553; Vol. 41, 1927, p. 399–409; Vol. 45, 1931, p. 334–350.

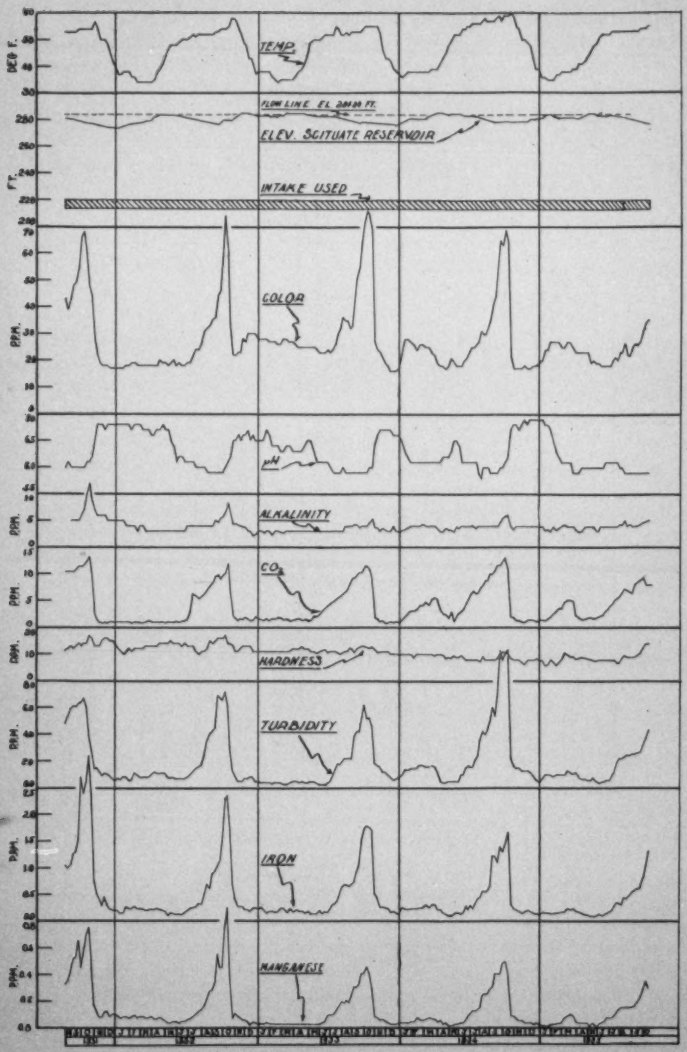

FIG. 1.— CHARACTERISTICS OF RAW WATER, 1931–1935.

solution thereby producing ferric iron as chlorinated-copperas for the coagulant. This treatment was continued until June 23, 1933, at which time the chlorinated copperas was displaced by anhydrous ferric sulphate, a product previously not available commercially.

Purposes of the present treatment are really six: removal of color, iron and manganese and production of a non-corrosive, stable effluent, free from dangerous bacteria. Need for removal of manganese forced the change from

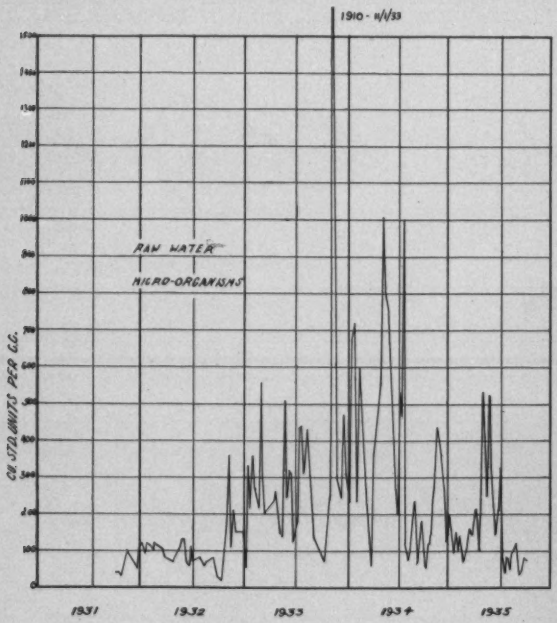

FIG. 2.— PLANKTON IN RAW WATER, 1931–1935.

alum coagulant after five years of use. The change to copperas and lime coagulation removed the manganese but was not entirely satisfactory in several ways. Handling the copperas was costly, floc formation was slow, and hardness and iron content of the effluent were greater than desired.

With chlorination of the copperas, the iron content of the effluent was reduced and hardness likewise. Difficulties in control of this treatment were due to the copperas caking and to irregularities in the control of the chlorine fed due to the makeshift set-up used. Ferric sulphate has no idiosyncrasies causing irregular control and as a coagulant possesses the combined advan-

tages of those previously used. Comparison of the various coagulants has been indicated in articles* published elsewhere.

The pH value of the coagulant dosed water is raised by hydrated lime to such a point as to insure a pH value of about 9.6 in the plant effluent. This is the point at which all half-bound carbon dioxide is eliminated, thus producing a water as nearly non-corrosive as possible.

TABLE 1.—SUMMARY OF RAW WATER CHARACTERISTICS.
Unless otherwise stated, results are expressed in parts per million.

	Averages for Fiscal Years Ending September 30.				
	1931	1932	1933	1934	1935
Color	22	25	31	29	23
pH value	6.5	6.4	6.3	6.2	6.3
Alkalinity	5.0	4.5	3.4	3.8	4.0
Carbon dioxide	4.1	3.4	3.8	4.95	3.9
Hardness	8.9	13.5	11.7	9.5	8.3
Turbidity	2.1	1.9	1.3	2.4	1.6
Iron (Fe)	0.34	0.54	0.43	0.46	0.28
Manganese (Mn)	0.21	0.17	0.11	0.12	0.09
Dissolved oxygen—Per cent. saturation	73	48	46	37	40
Total solids	30	32	33	28	24
Fixed solids	17	17	18	16	12
B.coli Index (Presumptive per c.c.)	0.012	0.010	0.012	0.015	0.015
Bacteria—20° C. count on agar	54	30	30	23	31
Bacteria—37° C. count on agar	5	4	5	4	6
Aluminum (Al)	0.25	0.33	0.21	0.26	0.29
Silica (SiO_2)	4.93	4.87	4.66	4.91	3.77
Calcium (Ca)	3.41	4.28	3.64	5.64	3.59
Magnesium (Mg)	0.33	0.23	0.15	0.41	0.37
Sulphate (SO_4)	5.90	5.42	4.45	5.59	4.47
Bicarbonate (HCO_3)	6.08	5.49	4.20	4.60	4.87
Nitrogen as Free Ammonia	0.077	0.066	0.057	0.068	0.040
Nitrogen as Albuminoid Ammonia	0.153	0.137	0.118	0.141	0.121
Nitrogen as Nitrite	0.000	0.001	0.002	0.001	0.001
Nitrogen as Nitrate	0.05	0.08	0.06	0.05	0.07
Chloride (Cl)	2.8	2.4	2.7	2.9	3.7
Temperature—(°F.)	47	46	47	48	47

TABLE 2.— COATING OF FILTER SAND AUGUST, 1935.
(Percentage of total weight of filter — medium.)

Filter No.	1-A	10-B
Loss by Ignition	0.63	0.38
Iron Oxide (Fe_2O_3)	0.45	0.33
Alumina (Al_2O_3)	0.16	0.06
Calcium Oxide (CaO)	0.12	0.05
Magnesia (MgO)	0.0026	0.0018
Manganese (Mn_2O_3)	0.019	0.016
Total	1.3816	0.8378

Note. Filter 1-A has been operated a much greater portion of the time than has filter 10-B.

*Water Works and Sewerage, Vol. 79, Sept. 1932, p. 301–4; Vol. 81, July 1934, p. 229–32.

Dosages of the various chemicals required are shown in Fig. 3. Ferrisul dosage varied from 0.5 to 0.75 grain per gallon and of hydrated lime from 0.8 to 1.05 grains per gallon.

Chemical Feed. In adapting the plant for these various treatments, only minor changes were made. Change in the point of application of the lime required installation of two 4-in. lines into the conduit leading to the mixer and of two water eductors to introduce the lime solution into the conduit

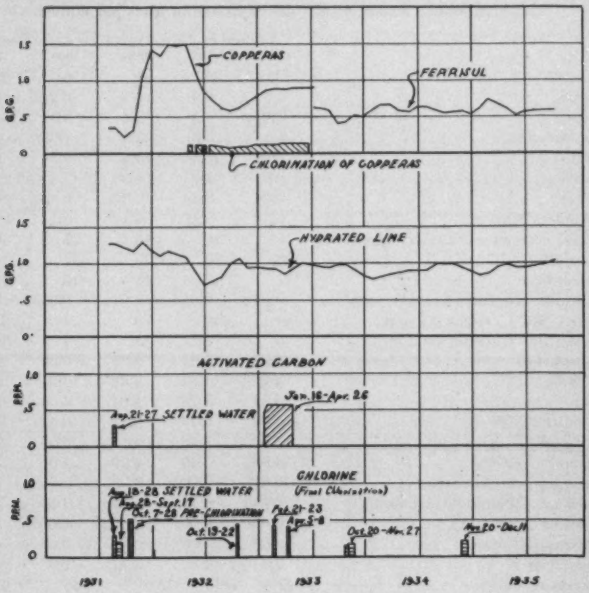

FIG. 3.—USE OF CHEMICALS, 1931–1935.

since the lime-feed apparatus is below the hydraulic grade at this point. Copperas feeding was carried out in the same manner as the previous alum dosing. It is not possible to store copperas in large bins because of caking; therefore considerable manual attention was required. When chlorination was adopted, two antique types of chlorinators were utilized to control the chlorine which was introduced through a hose line dropped down an 8-in. pipe line carrying copperas solution. Since research was under way looking toward the use of ferric iron in other forms, this make-shift equipment was continued in use up to the time of adoption of ferric sulphate as the coagulant.

The ferric sulphate being an anhydrous granular substance, it is stored and fed in the same way as was the alum. Since it is readily soluble in proportions of about one pound of chemical to two pounds of water, a pump is driven directly from the feed screw proportioning the water to the chemical. Chemical and water are fed continuously to a rubber-lined tank, equipped with a high speed mixer, providing at least twenty minutes retention. The continuous overflow from the solution tank is carried to the raw-water conduit through a 3-in. rubber-lined pipe.

Aëration. Aëration of the influent water immediately following ferric sulphate dosing produces a thorough mixing of the chemical and water. Carbon dioxide and other gases present in the raw water are undoubtedly disposed of together with some gas released by the chemical reactions of the coagulant. The magnitude of this effect is not readily determined since thorough mixing of the chemical and the water does not take place previous

TABLE 3.— ANALYSIS OF FILTER SAND.

	Effective Size — mm.		Uniformity Coefficient	
Filter No.	July, 1927	Sept., 1934	July, 1927	Sept., 1934
1-A	0.42	0.44	1.45	1.30
1-B	0.41	0.45	1.49	1.33
2-A	0.45	0.47	1.33	1.34
2-B	0.42	0.46	1.39	1.43
3-A	0.43	0.47	1.37	1.34
3-B	0.41	0.42	1.44	1.40
4-A	0.45	0.44	1,40	1.50
4-B	0.44	0.46	1.36	1.45
5-A	0.39	0.45	1.50	1.31
5-B	0.38	0.47	1.45	1.45
6-A	0.41	0.43	1.44	1.40
6-B	0.38	0.41	1.47	1.46
7-A	0.42	0.45	1.38	1.33
7-B	0.44	0.45	1.36	1.38
8-A	0.38	0.48	1.47	1.46
8-B	0.40	0.41	1.45	1.61
9-A	0.36	0.44	1.31	1.39
9-B	0.38	0.40	1.47	1.48
10-A	0.38	0.43	1.47	1.40
10-B	0.38	0.45	1.55	1.51
Average	0.40	0.44	1.45	1.43
Average Depth of Sand Beds—Inches	27.35	27.21		

to spraying from the aërator. Furthermore adsorption of gases and oils by the ferric iron may occur; therefore it is not readily possible to determine the relative efficiency of aëration or of adsorption.

Tastes and Odors. Tastes and odors present in the raw water have seldom withstood the effects of aëration and adsorption and have therefore been absent from the water after the floc has settled. During the winter months of 1932–33, the presence of *Uroglenopsis*, together with *diatoms* caused tastes which varied from purely fishy to cucumber. In the early

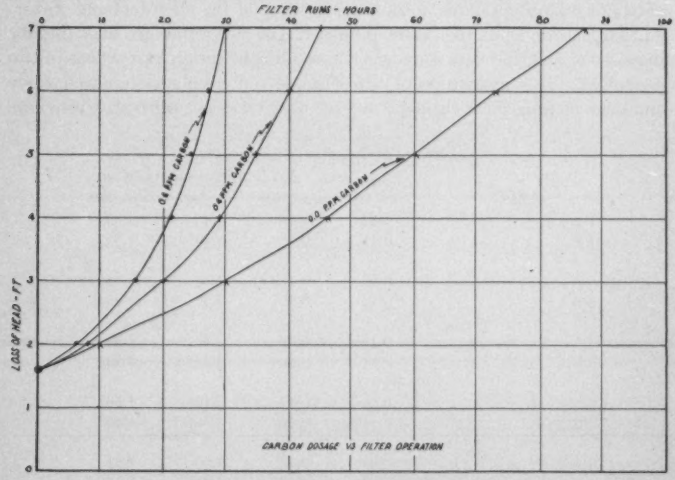

FIG. 4.— EFFECT OF ACTIVATED CARBON ON LENGTH OF FILTER RUNS.

months these tastes were removed, apparently mainly by adsorption of the oils on the iron floc. Around the first of the calendar year, as the temperature of the water approached its minimum point of 34° F., however, these reactions appeared to be reduced, and activated carbon was required to supplement odor and taste control. Between 0.5 and 0.6 p.p.m. of activated carbon was required to remove tastes completely when applied to the settled water as it entered the conduit to the filters. This is the point of greatest effectiveness so far as taste removal is concerned. However, it is also the point causing maximum effect on the filters since all the carbon passes onto the filters. Shortening of filter runs by carbon dosage is shown in Figure 4, indicating a reduction to one-half the normal run when using 0.4 p.p.m. of activated carbon and to one-third when dosing with 0.6 p.p.m.

In the application of activated carbon, the effectiveness of the adsorption is naturally dependent upon the surface exposed. Examination of

TABLE 4.—OPERATION AND TREATMENT.

	Averages for Fiscal Years Ending September 30.				
	1931	1932	1933	1934	1935
Volume of Water Filtered:					
m.g.	9247.72	9004.87	9300.54	9809.94	10015.18
m.g.d.	25.392	24.604	25.481	26.876	27.439
Alum: lb.	524 160	....	....	....	....
grains per gal.	0.45	....	....	....	....
Copperas: lb.	61 615	1 344 460	771 220	....	....
grains per gal.	0.28	1.03	0.82	....	....
*Chlorine: lb.	....	47 854	108 768	....	....
grains per gal.	....	0.12	0.12	....	....
Ferric Sulphate: lb.	....	....	277 785	832 824	834 790
grains per gal.	....	....	0.58	0.58	0.59
Hydrated Lime: lb.	591 300	1 370 450	1 359 650	1 291 409	1 335 721
grains per gal.	†	1.02	0.96	0.90	0.94
‡Chlorine: lb.	6 251	....	736	1 301	809
p.p.m.	‡	....	0.43	0.17	0.19
Filters: Number of Washes	1 879	1 541	775	670	614
Average hours run	28.08	33.89	68.82	82.64	88.51
Yield per run—m.g.	4.92	5.84	12.00	14.64	16.37
Wash water: m.g.	208.38	200.44	120.41	110.23	104.89
per cent. of total filtered	2.26	2.23	1.29	1.12	1.05
Plant Effluent: m.g.	9 039.34	8 804.43	9 180.13	9 699.71	9 910.29
m.g.d.	24.765	24.056	25.151	26.574	27.151

Treatment: Alum coagulation with effluent lime-treatment to Aug. 9, 1931. Copperas-lime coagulation Aug. 9, 1931 to May, 1932. Chlorinated-copperas and lime coagulation May, 1932, to June 23, 1933 (ferric chloride used nine days in July, 1932—36 639 lb.). Ferrisul-lime coagulation June 23, 1933 through Sept. 30, 1935.

*Chlorine used for chlorinating copperas for coagulant.
†Dosage 0.28 g.p.g. to Aug., 1931 and 1.26 g.p.g., Aug. 9 to Sept. 30.
‡Chlorine used as sterilising agent (p.p.m.) calculated on water actually treated. Final ammonia-chlorine treatment Mar. 29 to May 9, 1931 — Chlorine dosage 0.55 p.p.m.— Ammonia dosage 0.19 p.p.m. Chlorine dosage at other periods in 1931, 0.23 p.p.m. Raw water was pre-chlorinated Oct. 18–Nov. 10, 1930, 2 682 lbs., 0.52 p.p.m. also Oct., 1931 (16 days), 1 783 lbs., 0.51 p.p.m., not included in figures in the above table.

carbon mixtures fed by a commercial type of unit in which the carbon dropped directly from the feed fingers into a water eductor showed that the material was bunched. A thirty-gallon barrel with float control was inserted between the feed apparatus and the eductor, with a high-speed centrifugal pump continuously re-circulating the mixture and dispersing the carbon. Examinations of the dispersions thus produced indicated that perhaps twice as much surface was freely exposed after this modification.

Filtration. Effectiveness of a coagulation process may be quantitatively considered in five different ways; (1) by the quality of the effluent, (2) by the amount of water filtered per run, or rate of increase of lost head, (3) by increase in depth of sand bed, (4) by increase in size of sand grains, and (5) by direct determination of the amount of coating on the sand grains. The latter three all indicate amount of clogging of the filter bed.

The quality of the effluent is indicated elsewhere in this paper. The amount of water filtered per run is shown in Table 4 for the past five years of operation. Marked increases from year to year are noted. Characteristics of filter operation are shown in Fig. 5. The record of average depth of sand beds, as shown in Table 3, indicates a reduction of 0.14 inch in seven years. In the same table are shown screen analyses of the sand in 1927 and 1934 exhibiting remarkably little change during the years. By all these measures coagulation is now indicated to be of the best quality.

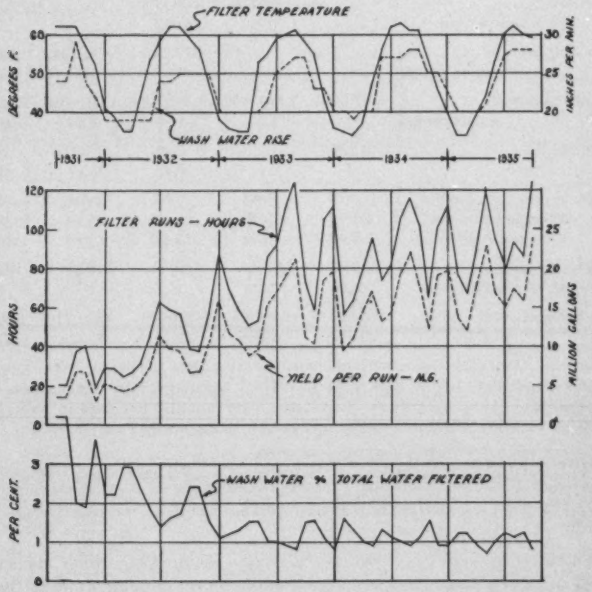

FIG. 5.— METHODS AND RESULTS OF FILTER OPERATION, 1931–1935.

When changing the method of treatment in August, 1931, it was necessary to clean the filter sand. This was done with caustic soda. Previous to that time, water was delivered at a pH of 5.8 to 6.2; the material deposited on the filter sand was therefore adsorbed from an acid solution. The new method required filtration at a pH of 9.6 to 10.0; such alkaline water dissolved the materials previously deposited and made cleaning of the sand necessary.

Very slight coating is now present on the sand as shown by analyses given in Table 2 and made after four years of operation with iron coagulants.

Maximum coating amounted to less than 1.5 per cent. of the sand weight four years after caustic cleaning.

Sludge Stability and Basin Cleaning. The two coagulation and sedimentation basins are operated in series, the larger of these being the second in series as operated. This larger basin has an area of approximately 1⅛ million square feet and has never been cleaned. Measurements in June of this year indicated a maximum depth of sludge of two feet with an average of approximately one foot. The smaller basin (area about 440 000 sq. ft.) was completely cleaned in the spring of 1930. In June, 1935, measurements showed the sludge to be seven feet deep in places, the average for the basin being two feet. These figures represent a maximum of forty per cent. of depth and an average of twenty per cent. of the basin capacity occupied by sludge. The smaller basin was cleaned in August, 1935, by draining and flushing with a hose stream under fire pressure. Rocks, pits, and other irregularities in the bottom make cleaning rather slow work. Two hose streams were employed for twenty-two hours and three for thirty-one hours, a total of one hundred and thirty-seven hose hours.

Examination of water at various depths before cleaning showed that water immediately over the sludge had high oxygen content and normal pH, color, alkalinity, etc., thereby proving that any decomposition taking place in the sludge was not sufficient to affect the water quality even though the basin had not been cleaned for five years. An unusual degree of sludge stability is thus manifest.

TABLE 5.—BACTERIAL ANALYSES.
Yearly Averages, 1931–1935.

	Fiscal Years Ending September 30.				
	1931	1932	1933	1934	1935
B. coli Index (Presumptive—per c.c.)					
Raw Water	0.012	0.010	0.012	0.015	0.015
Settled Water	0.004	0.005	0.006	0.010	0.004
Filtered Water	0.003	0.002	0.003	0.002	0.001
Final Effluent*	0.002	0.002	0.003	0.002	0.001
Tap (City)	0.002	0.002	0.003	0.003	0.002
Bacterial Counts (20° C. Agar-Colonies per c.c.)					
Raw Water	54	30	30	23	31
Settled Water	421	244	274	190	183
Filtered Water	330	103	139	116	108
Final Effluent*	254	103	139	116	92
Tap (City)	147	87	135	85	78
Bacterial Counts (37° C. Agar-Colonies per c.c.)					
Raw Water	5	4	5	4	6
Settled Water	12	4	13	10	8
Filtered Water	14	2	1	1	1.5
Final Effluent*	13	2	1	1	1.4
Tap (City)	2	1	1	1	1.6

*Final Effluent Average: filtered water chlorinated March 29 to May 9, and Aug. 28 to Sept. 17, 1931; Oct. 19 to 22, 1932; Feb. 21 to 23; April 5 to 8 and Oct. 20 to Nov. 27, 1933; Nov. 20 to Dec. 11, 1934.

Bacteria. Bacterial counts and *B.coli* content of raw water have continued very low, and chlorination has been required only a small part of the time. The coagulation basins are large and shallow, and it might seem that bacterial growths would flourish here. Such is not the case, possibly due to the high pH of the treated water. A summary of yearly averages of bacterial and *B.coli* counts is given in Table 5. Chlorine was used as a sterilizing agent or safety factor in 1931 on 74 days; in 1932 on none; in 1933 on 11 days; in 1934 on 39 days; and in 1935 on 22 days.

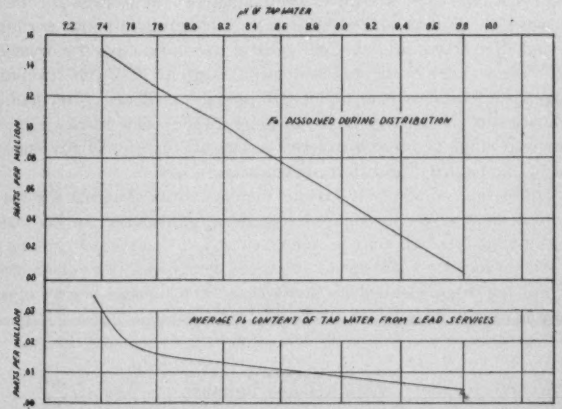
pH OF TAP WATER
7.2 7.4 7.6 7.8 8.0 8.2 8.4 8.6 8.8 9.0 9.2 9.4 9.6 9.8 10.0
PARTS PER MILLION
Fe DISSOLVED DURING DISTRIBUTION
AVERAGE Pb CONTENT OF TAP WATER FROM LEAD SERVICES

FIG. 6.— EFFECT OF pH VALUE ON SOLUTION OF IRON AND LEAD FROM DISTRIBUTION SYSTEM, 1928–1935.

Effluent Quality and Distribution. The plant effluent is more stable than under any previous treatment. Few cases of discolored water are now observed. So far as can be determined, no deposition is taking place within the cold-water piping and very slight deposition after hot-water heaters. A few times each summer, on days of heavy draft, a slight sediment may appear in city tap samples; on one day during the past summer two complaints were received from this cause. These sediments invariably contain manganese. Since no manganese has entered the distribution system since 1931, it may be seen how long sediments remain within distribution piping.

The pH value of the treated water is about 9.6. Effectiveness of such treatment in elimination of corrosion is indicated by Fig. 6 which shows the average iron picked up by the water between the purification plant and the consumer's taps. The data show approximately 0.016 p.p.m. of iron at pH 9.6. This is approximately one-tenth the amount which was dissolved at a pH of 7.6. Where lead services and household plumbing are in use numerous

TABLE 6.— CHARACTERISTICS OF PLANT EFFLUENT.
Yearly Averages — 1931–1935.
(Unless otherwise stated, results are expressed in parts per million.)

	Fiscal Years Ending September 30.				
	1931	1932	1933	1934	1935
Color	4*	10	9	7	8
pH value	9.3	9.6	9.7	9.7	9.6
Alkalinity (methyl orange)	10.2	18.2	15.1	14.1	15.6
Carbon dioxide	0.0	0.0	0.0	0.0	0.0
Phenolphthalein alkalinity	3.6	8.7	8.4	7.2	8.4
Hardness	19.8	35.9	27.5	25.3	25.4
Turbidity	0.1	0.1	0.0	0.0	0.0
Iron (Fe)	0.06	0.11	0.05	0.04	0.04
Manganese (Mn)	0.15	0.00	0.00	0.00	0.00
Dissolved oxygen — per cent. saturation	83	79	76	65	68
Total solids	21	55	50	50	47
Fixed solids	14	35	30	33	33
B. coli Index (Presumptive per c.c.)	0.002	0.002	0.003	0.002	0.001
Bacteria — 20° C. count on agar	254	103	139	116	92
Bacteria — 37° C. count on agar	13	2	1	1	1.4
Aluminum (Al)†	0.39	0.27	0.09	0.15	0.155
Silica (SiO_2)†	5.93	6.42	5.91	5.62	6.20
Calcium (Ca)†	7.56	13.00	10.60	11.03	9.35
Magnesium (Mg)†	0.56	0.34	0.21	0.46	0.39
Sulphate (SO_4)†	9.53	10.04	9.90	10.46	9.99
Nitrogen as Free Ammonia†‡	0.072	0.016	0.028	0.041	0.024
Nitrogen as Albuminoid Ammonia†	0.097	0.061	0.095	0.123	0.077
Nitrogen as Nitrite	0.001	0.021	0.001	0.001	0.001
Nitrogen as Nitrate	0.05	0.09	0.05	0.04	0.07
Chloride (Cl)	2.9	2.8	3.5	2.8	3.7
Temperature — (°F)	51	50	49	49	49

*Color of city tap water averaged 9 due to color return after final lime treatment.
†Average analysis of city tap, not the plant effluent.
‡Free ammonia increased by ammonia-chlorine treatment of effluent, Mar. 20 to May 9, 1931.

analyses are made. These indicate an average lead content of only 0.005 p.p.m. which is one-fourth of the average obtained at pH 7.6.

The hardness of the tap water is somewhat greater than with the original alum coagulation, causing slightly greater soap use and no doubt greater scale formation. However, this hardness of 25 p.p.m. is less than that of most surface-water supplies and is no more than necessary to produce the most desirable quality of water for the major part of the consumers, also to protect the piping of the distribution system.

Characteristics of the plant effluent are shown in Table 6.

Chemicals. Ferrisul is purchased under contract specifications of not less than 90 per cent. of water-soluble ferric sulphate [$Fe_2(SO_4)_3$]. The

ferrous iron content is not to exceed 1½ per cent. as Fe. The material received has proved much better than the specifications require.

Hydrated lime specifications call for at least 90 per cent. of water soluble calcium hydrate [$Ca(OH)_2$]. The lime received has easily met this specification.

RECENT PROGRESS IN SUPPLYING LESS CORROSIVE SOFT WATER.

BY MALCOLM PIRNIE.*

[*Read September 18, 1935.*]

The quality of water as delivered to consumers in several municipalities supplied with filtered water from soft water sources has been substantially improved in recent years. This has been brought about by extensive experiments in the laboratories of the filter plants to demonstrate the causes of deterioration in quality of water during distribution and to determine what changes could be economically made in the purification processes which would deliver water of the highest possible degree of stability to the existing distribution systems so that it could pass through the pipes to the consumers without change in quality. The results of careful research throughout the water works field were available as a wealth of information from which pertinent methods of procedure were selected and used in the design and conduct of the experimental work. The outstanding degree of success realized, in the application of purification processes dictated by laboratory investigations when established as routine operations for the filter plants, reflects a high degree of credit not only upon those who demonstrated what could be done to improve the water treatment and then had the courage to make the changes in plant operation but also to all research workers in the water works field who have made their findings available for general use.

Early in the use of rapid sand-filters for purifying soft waters from rivers and impounding reservoirs for municipal water supplies it was found that the apparent quality of a filter effluent was much superior to the quality of water received by consumers. Rusting and clogging of pipes was greatly accelerated, and red water was a constantly recurring scourge and cause of consumers' complaints. Accumulations of mud with attending bad tastes and odors developed in dead end pipes, and samples of water drawn through house services and piping of lead, when analyzed, often showed alarming quantities of lead in solution. These unsatisfactory conditions were often more pronounced following the introduction of filtration than experienced previously, and rapid sand-filters were not the only offenders. Similar although less severe troubles resulted from the introduction of slow sand-filters, being more pronounced in the summer and fall seasons when there was maximum bacterial activity in the sand beds.

Improvement in rapid sand-filter plant design from the first tub filters built in the late 80's occupied the center of the water purification progress stage for nearly forty years. Developments of water purification processes

*Consulting Engineer, New York, N. Y.

have been most effective during the last fifteen years except for the all important introduction of chlorination in 1908, which, by virtue of its universal effectiveness in sterilization of filter effluents actually delayed improvements in other important methods of water treatment.

The writer did not relish the sentiment expressed in a poem that appeared in a newspaper of a city where he was laboriously striving to improve the purification processes about eighteen years ago, but the poem is quoted as justified in the light of present knowledge of proper water treatment and because some plants are still operated so poorly today as to justify the same appraisal of quality of the water as delivered to the consumers.

THE CITY WATER

(Apology to Danny Deever.)

"What makes the water taste so bad?" demurely asked the maid.
" 'Tain't fit to drink, 'tain't fit to drink," the washerwoman said.
"What makes it smell so awful rank?" demurely asked the maid.
"It smells of skunks, it smells of skunks," the washerwoman said.
"They are filterin' of it daily, they are runnin' it thro' sand,
"They are fillin' it with alum, they are purgin' of it grand,
"They pump it to the reservoir, an' then they let it stand,
"And it tastes and smells of swamp rats in the mornin'."

"What can we use the water for?" demurely asked the maid.
"For raisin' frogs, for raisin' frogs," the washerwoman said.
"What will we drink from day to day?" demurely asked the maid.
"I'll give it up, I'll give it up," the washerwoman said.
"It's full of deadly bugs and things; at least that's what I hear.
" 'Twill kill us dead entirely, if we drink the stuff, I fear,
"Ain't nothin' left for us to do but get some lager beer,
"And drink it good and plenty in the mornin'."

In view of the simile used above and a famous taste and odor trouble which occurred but once at Holyoke, Mass., apology to Mr. Patrick Gear should be added.

The excellent paper by Mr. Elwood L. Bean* "Providence Water Treatment" gives a complete history of the main factors leading up to the present successful treatment of the water of Providence which suffered from a severe red-water plague in dead ends of the distribution system in the late Fall of 1929.

The Providence filters had been in operation for more than two years before the trouble began, and the treatment using alum in the raw aërated water and lime in the effluent had not been varied except to experiment with intermittent alum dosing in October and December, 1928. The alkalinity of the effluent had been raised gradually from a pH value of 7.2 for May, 1927, to a pH value of close to 8.0 during 1929. For the period from April, 1929, when the records were changed to record tap water

*See this issue of the JOURNAL.

analysis, to the time of the red-water troubles that developed in the late fall, the following table gives interesting results.

Monthly Averages in 1929.

Month.	pH Value.		Free CO_2 — p.p.m.			Iron — p.p.m.		
	Effluent.	Tap.	Effluent.	Tap.	Increase.	Effluent.	Tap.	Increase
Apr.	8.0	8.0	0.2	0.2	0	0.09	0.17	0.08
May	8.0	8.0	0.1	0.2	0.1	0.20	0.35	0.15
Jun	7.9	8.1	0.4	0.2	—0.2	0.16	0.25	0.09
Jul	8.0	7.8	0.2	0.4	0.2	0.15	0.16	0.01
Aug.	7.7	7.7	0.6	0.5	—0.1	0.15	0.27	0.12
Sep.	7.9	7.4	0.3	0.9	0.6	0.10	0.25	0.15
Oct.	8.2	7.7	–0.2	0.5	0.7	0.19	0.38	0.19
Nov.	7.9	7.3	–0.2	0.5	0.7	0.13	0.42	0.29
Dec.	8.8	8.4	–1.2	–0.7	0.5	0.06	0.17	0.11
Ave. Apr.–Aug.	7.9	7.9	...	....	0	....	....	0.09
Sep.–Nov...	8.0	7.5	....	....	0.7	....	....	0.21

Obviously something was happening in the distribution system during the fall which did not happen during the late spring and summer. The 0.5 reduction in pH, the 0.7 p.p.m. increase in carbon dioxide and the 0.21 p.p.m. increase in iron in the tap samples suggested the possibility that bacterial activity in the slime linings of the distribution pipes caused the trouble. Samples of red water collected from troublesome dead ends in early December pointed more forcibly to this cause as they showed much greater increase in carbon dioxide and iron and reduction in pH.

The efforts to prevent a recurrence of a red-water epidemic resulted in an acute black-water epidemic early in May, 1931. The pH of the effluent had been raised to 9.4 in March and was the same in the tap water. Effluent iron was only 0.03 p.p.m. and tap-water iron 0.06, an increase of 0.03 p.p.m. Bacteria in the tap water averaged 5 per c. c. on agar at 20° C. and 0 per c.c. on agar at 37° C. Ammonia-chlorine treatment of the effluent was started on March 29 and continued until May 9, with an average application of 0.58 p.p.m. of chlorine and 0.19 p.p.m. of ammonia during April. Bacteria in the tap water averaged 1 per c.c. on agar at 20° C. and 0 per c.c. on agar at 37° C. From May 11, two days following the end of the chloramine treatment, the bacteria of the cold water variety increased enormously in the tap water, which was also high in manganese. The average count for the ten days from May 11 to 20 was 1906 per c.c. on agar at 20° C. and only 4 per c.c. on agar at 37° C. There was no doubt that these bacteria came from the pipe slimes along with manganese that had been deposited there. After this experience, it was certain that the manganese present in the raw water must be precipitated prior to filtration if the consumers were to be furnished with water of the best possible quality.

The ammonia-chlorine treatment of the water in the Hinkley Reservoir pipe line at Utica as reported by J. Walter Ackerman and by the New England Water Works Association's Committee on pipe co-efficients is

analogous to the Providence experiment. Under date of September 11, 1935, Mr. Ackermann reports that 16 determinations of C in the Williams and Hazen formula have ranged from 140 to 144 up to April, 1935. Thus he has successfully prevented tuberculation of this main for more than a year by maintaining water in it that is actively antagonistic to growth of bacteria. Formerly this main has required cleaning at least every eighteen months since its first cleaning to keep its coefficient above 100. About six months after the sixth cleaning of the Hinkley pipe line in June, 1931, Mr. Robert W. Sawyer collected samples of water from the pipe at the reservoir, at the point of discharge into Marcy Reservoir and at the Marcy outlet to the city supply main. Professor George C. Hodges analyzed the samples indicating 0.786 p.p.m. of iron in the Hinkley water with a reduction of 0.403 p.p.m. of iron as the water passed through the pipe line to Marcy Reservoir and a further reduction in iron of 0.092 p.p.m. in the passage through Marcy Reservoir to the outlet. Iron was apparently being deposited in the pipe line at a rate of about seven-eighths of a ton per year based upon a flow of 14 m.g.d. This iron in combination with organic matter, oxygen, hydrogen and other substances extracted from the passing water would account for considerable incrustation on the interior of the pipe line. Additional incrustation would result from iron dissolved from the pipe walls due to concentrations of carbonic acid in the slimes next to the exposed metal. This action at other times of the year is accelerated to produce a higher iron content in the water discharging into Marcy Reservoir than is present in the Hinkley water entering the pipe. However, the Hinkley intake is not far above the bottom of the reservoir and receives the products of stagnation of bottom reservoir water relatively high in iron for a considerable proportion of the year.

To observe the depreciation of the distribution system of the Indianapolis Water Company in 1932, many samples of pipe removed from the system were carefully studied. Samples which had been in service for various periods prior to their removal in or before 1906 consistently showed relatively heavy incrustation when compared with the light or absent incrustations of pipes installed subsequent to that date and removed after equal periods of service. The water at Indianapolis is hard and a substantial part of it is drawn from wells. The well water contains iron and is delivered without treatment to the clear-water reservoirs where it mixes with the filtered surface water. Chlorination of the filtered water has been continuous since hypochlorite of lime was first applied in 1906. It is possible that chlorination of a hard water has been more than ordinarily effective in inhibiting the development of slimes on the interior pipe walls, and that without such growths to entrain the iron a substantial part of it has been drawn through the taps and most of the balance settling as a soft mud has been expelled by the practice of systematic flushing of mains.

The presence of manganese in the Scituate Reservoir Water at Providence made it mandatory to complete coagulation at a pH of at least

9.0 before filtration. This dictated the use of an iron coagulant with lime. Copperas, chlorinated copperas, ferric chloride and ferric sulphate were extensively studied. All but the first were equally effective per unit of iron, and in the course of the experiments ferric sulphate was developed on a commercial scale for use in the Providence plant under the trade name of Ferrisul. In its pebble-like granular form, it is an ideal coagulant for storage in bulk in large bins and for feeding through dry-feed machines. It has been used with marked success in the equipment originally installed to store and feed alum by the addition of new solution equipment designed by Mr. Philip J. Holton, Jr.

To obtain the best results, the added iron contacts with the raw water first in the highly acid stage after which the volatile gases are expelled in the influent aërator. Lime is added to produce a pH of about 9.8 and the water passes through the mixer, then through the basins to the filters. The doses are adjusted to secure the minimum iron content in the filter effluent. Monthly averages of iron content of the filter effluent range between 0.03 and 0.05 p.p.m., and manganese has been constantly absent when testing for 0.01 p.p.m. In the late summer there is some recarbonation of the dosed water as it passes through the settling basins and filters. In August, 1935, this reduced the pH of the dosed water from 9.8 to 9.5 requiring only a slight increase of the lime dose to maintain the desired pH of the effluent. Ammonia-chlorine treatment of the effluent has not been practiced due to its demonstrated effect upon the deposits accumulated in the distribution system. The manganese determinations show that these deposits are gradually passing out with the tap water as indicated by an average manganese content of 0.08 p.p.m. in the August tap water compared witb 0.00 p.p.m. in the filter effluent.

Bottom water from the Scitutate Reservoir seems to be preferable to water from all other levels for use as raw water in the present treatment. It is the coldest water available in summer, with a temperature of 53° F. in August, contains maximum concentrations of iron and manganese to aid in coagulation and has no fresh end products of algae growths in the surface water. During the height of the late summer stagnation period when considerable iron is present, it would be beneficial to chlorinate the raw water to oxidize more rapidly the iron- and manganese-containing organic compounds present, which would reduce the amount of iron otherwise needed. This could be accomplished economically with the use of chlorinated copperas as the coagulant with its attendant substantial changes in chemical equipment, but might require treatment with activated carbon such as followed this method of coagulation from January to April, 1933.

The outstanding advantages of the present water purification process are obvious when compared with the results of the earlier treatment. Although iron is used as the coagulant, only 0.04 p.p.m. has been present in the plant effluent as an average for the past two years. The pick-up of iron from the distribution system between the plant and tap at an average

pH of between 9.7 and 9.6 has been only 0.014 p.p.m., or one-tenth of the iron pick-up of 0.14 p.p.m. at a pH of 7.6 observed in the first two years' operation. Present annual consumption is close to 10,000 m.g., and the total iron dissolved at pH 7.6 would be slightly under 6 tons per year as compared with about half a ton per year at pH 9.7. The decrease in solution of iron is approximately half a ton per year for each 0.2 increment in pH. For this distribution system, weighing approximately 60,000 tons, one per cent. of it would be dissolved by water of pH 7.6 in one hundred years while it would take a thousand years with water of pH 9.7. Water samples from lead services now contain but 0.004 p.p.m. of lead whereas formerly with water of pH 7.6 they averaged close to 0.02 p.p.m. of lead which was one fifth the upper limit of 0.10 p.p.m. of the U. S. Treasury Department Standard for Interstate Carriers. The present quantity of lead is only one twenty-fifth of the standard upper limit. These benefits are realized without exceeding an average total hardness in the water delivered to consumers of 26 p.p.m.

The soft colored water used as the source of supply for the Palm Beaches in Florida contains no manganese, and alum is used as the coagulant, with lime added to the aërated effluent from the filters to obtain a final pH of about 9.7. In September, 1932, adequate provision was made for introducing well water containing calcium bi-carbonate in controlled quantities into the coagulated raw-water line between the pumps and the influent aërators.

In the first three quarters of 1932, before controlled bi-carbonate alkalinity of the raw water was possible, the following average results were obtained showing a pick-up in the distribution system of 0.012 p.p.m. of iron and a deposition of 0.018 p.p.m. of aluminum.

	pH Value.	Color — p.p.m.	Iron — p.p.m.	Aluminum — p.p.m.
Water delivered.....	9.8	15	0.044	0.092
Tap water.....	9.8	15.7	0.056	0.074

Annual averages for 1934 showed marked improvement in stability of the water as delivered to the mains as follows: the pick up in iron being halved to 0.006 p.p.m. and deposition of aluminum being cut to one-third or 0.006 p.p.m.

	pH Value.	Color — p.p.m.	Iron — p.p.m.	Aluminum — p.p.m.
Water delivered.....	9.7	8.8	0.013	0.025
Tap water.....	9.7	10.5	0.019	0.019

Since September, 1934, when the point of application of chlorine in the filtered-water reservoir was changed and a definite residual chlorine carried in the tap water, all monthly averages have shown no change in the iron content of 0.01 p.p.m. in samples of water delivered and drawn from the taps. This condition has continued in spite of a recent gradual drop in pH from 9.7 to 9.0 during the eight months of 1935 for which records are availa-

ble. During the same period, the average monthly raw-water color has varied between 51 and 187 and the color of water delivered has varied from 9 to 13.

Water temperature at West Palm Beach is often above 90° F., and some trouble from red water still occurs where there is little flow in some of the old heavily incrusted pipes. The large majority of consumers in the Palm Beaches, as in Providence, are now enjoying an excellent quality of water as drawn at all times from the taps. At West Palm Beach, with alum used as the coagulant at the rate of 3 grains per gallon throughout 1924, an aluminum content in the filtered water of only 0.025 p.p.m. is proof of the high efficiency of the purification process. The results are particularly striking when compared with tests in June, 1935, of a northern municipal plant using 2½ grains per gallon of alum and turning out an effluent containing 3 p.p.m. of aluminum which is 120 times the aluminum content of the West Palm Beach filter effluent. The consumer of this northern plant water who initiated its investigation would appreciate the poem quoted in this paper.

At Providence where 0.58 to 0.59 grains per gallon of ferric sulphate are added to raw water containing as averages in 1934 and the first ten months of 1935 from 0.46 to 0.22 p.p.m. of iron and from 0.12 to 0.07 p.p.m. of manganese, it is gratifying to obtain an effluent averaging for the entire period 0.04 p.p.m. of iron and 0.00 p.p.m. of manganese.

From the records of many investigations that have been made it is safe to assume that all deep reservoirs and lakes in which soft waters are impounded north of the tropics are automatic producers of coagulants and are natural mixing and coagulating basins. During the stagnation periods organic compounds of iron and manganese are changed by bacterial activity in the bottom precipitates into the colorless soluble ferrous and manganous bicarbonates. These salts remain in the bottom water until the overturn thoroughly mixes them with all of the water in the reservoir. Then follows oxidation, coagulation and precipitation, carrying to the bottom much of the fresh organic iron and manganese compounds stored in the reservoir from stream run-offs since the previous overturn. Thus the supply of coagulant is increased to be more effective in treating all of the water during subsequent overturns until some balance is reached. This would seem to be a more complete explanation of decolorization of soft waters in impounding reservoirs than that usually accepted that sunlight bleaches the color. Obviously certain of the rays in sunlight would accelerate the process of oxidation of the coagulant after it is mixed with the fresh coloring matter. Investigations of such bodies of water as the Scituate, Wanaque, Wachusett and Sudbury Reservoirs; Squam Lake in New Hampshire and Moswansicut Lake in Rhode Island demonstrate the operation of such a cycle.

In the tropics, mixing of waters impounded in deep reservoirs is usually confined to the upper 20 to 30 feet which are stirred by wave action. Where there is no overturn due to temperature differentials, variable velocities of

wind will allow the coagulants to work upward in calm weather to be mixed with the upper water strata in times of high winds.

Conclusions. Soft water delivered to existing distribution systems in which a large proportion of the pipes are of cast-iron should have the greatest possible degree of stability in contact with iron and in contact with lead where this metal has been used for services and house plumbing. Such a water will have the following characteristics:

A pH value of 9.6 to 9.8, in which case all of the carbonates are present as normal carbonates.

An iron content of 0.05 p.p.m. or less if possible to prevent deposition of iron hydrate in the pipes.

A manganese content of 0.00 p.p.m., as any manganese present will precipitate as a black mud in the pipes at a high pH causing occasional black-water complaints.

An aluminum content of 0.03 p.p.m. or less, if possible, when alum is used as the coagulant to minimize deposition as a light mud in the pipes. Due to the presence of 0.26 to 0.31 p.p.m. of alumina in the raw water at Providence and coagulation at a high pH the amount present as Al_2O_3 in the plant effluent has averaged 0.29 p.p.m. in 1934 and 0.33 p.p.m. in 1935 with corresponding tap-water amounts of 0.28 p.p.m. and 0.30 p.p.m. This suggests deposition of alumina in the pipes amounting to only 0.01 p.p.m. and 0.03 p.p.m., whether as a mud or a coating is not now known.

Temperature as low as feasible for general palatability of tap water and to inhibit bacterial activity in low-velocity sections of the distribution system.

Residual chlorine, if possible, should be present to give a slight residual of 0.02 p.p.m. in tap water to inhibit bacterial activity in the mains, even if not needed to give negative *B.coli* counts.

The purification process at Providence to obtain these results has been adequately recorded in this JOURNAL and is applicable to most soft waters containing manganese.

Using alum as the coagulant at West Palm Beach in the absence of manganese, the above conditions with the exception of temperatures are realized or bettered. The secret of success and consistency in the treatment lies in the proportional supply of bicarbonate alkalinity which can be added to the dosed water in any amount necessary to compensate for the alum dose dictated by the amount and degree of freshness of the color. In 1934 the aërated filter effluent had the following average characteristics:

Methyl orange alkalinity	6.66 p.p.m.
pH value	6.63
Color	6 p.p.m.
Hardness	39.8 p.p.m.
Aluminum	0.01 p.p.m.

After lime treatment and chlorination the water had the following average characteristics:

Methyl orange alkalinity	25.1 p.p.m.
pH value	9.67
Color	8.8 p.p.m.
Hardness	56.8 p.p.m.
Iron	0.013 p.p.m.
Aluminum	0.035 p.p.m.

The great majority of all consumers connected to the systems supplied by water from the Providence and West Palm Beach filter plants are constantly receiving water of the highest quality with a minimum of change during its passage through the piping systems. It is well, however, to sound a note of warning in the use of a water of pH 9.7. Zinc is highly soluble in such water whether hot or cold, and metals constantly in contact with this water should contain little or no zinc. Lead, iron and copper seem to be highly resistant to corrosion in waters of pH 9.7 as furnished at Providence and West Palm Beach.

May progress in supplying less corrosive soft waters continue until poems are written by consumers comparing the water drawn from the mains through the piping in their homes, not to swamp rats, but to the nectar of Mount Olympus.

PROCEEDINGS.

FIFTY-FOURTH ANNUAL CONVENTION.

PROVIDENCE, RHODE ISLAND.

September 17 to 20, 1935.

The following is a synopsis of such parts of the proceedings of the Fifty-fourth Convention as appear to be of value for the record.

The Fifty-Fourth Annual Convention of the NEW ENGLAND WATER WORKS ASSOCIATION was held at the Biltmore Hotel, Providence, Rhode Island, September 17 to 20, 1935.

President Howard M. King presided at the general sessions.

TUESDAY, SEPTEMBER 17, 1935.

Morning Session.

Reports of the Secretary, Treasurer, Editor and Water Works Education Committee were read and accepted (See p. 448).

CLOSING OF POLLS.

The President closed the polls and appointed John P. Miller, Harold L. Brigham and Arthur C. King as Tellers of Election.

Luncheon Meeting.

The President presented the Honorable Charles A. Maguire, Commissioner of Public Works, Providence, R. I., who introduced the guests of the Association: Honorable John P. Hartigan, Attorney General of Rhode Island, who welcomed the Association on behalf of Governor Greene; and Honorable James E. Dunne, Mayor of Providence who extended the welcome of the City of Providence.

Certificates of honorary membership were presented to Frank E. Winsor and Stephen H. Taylor and the Dexter Brackett Memorial Medal to Karl R. Kennison.

PRESENTATION OF HONORARY MEMBERSHIPS.

THE PRESIDENT. The next item on the program is the presentation of honorary memberships. An honorary membership is the highest distinction that this Association can award to any member. The Executive Committee has at this convention awarded that honor to two men,—Frank E. Winsor and Stephen H. Taylor. Mr. Robert Spurr Weston will introduce Mr. Winsor.

ROBERT SPURR WESTON. Mr. President and members of the Association: I come, not to introduce Frank E. Winsor, for he is known to you already, but to present him as an Honorary Member of this Association.

He is a native of Providence, the recipient of four degrees from Brown University, including the honorary degree of Doctor of Science, and a trustee of that institution. He has been successively connected, in positions of increasing responsibility and trust, with the Metropolitan sewerage system and the Metropolitan Water Works in Massachusetts, the Investigation for Water Supply in New York, the Charles River Basin Commission, the Catskill Water Works as department engineer for 32 miles of the Catskill aqueduct and the Kensico and Hill View Reservoirs, the New Water Supply for Providence as chief engineer, and finally the Metropolitan District Water Supply Commission, now completing the Quabbin Aqueduct and Reservoir, as chief engineer.

He has been vice president of the American Society of Civil Engineers and president of the Boston Society of Civil Engineers, the Providence Engineering Society, and this Association, all of which positions he has filled with credit and satisfaction. He is a Fellow of the American Academy of Arts and Science and other distinguished organizations.

Wise and effective officer of technical associations; efficient and economical designer of enduring engineering works; recipient of many testimonials of honor and affection from associates and friends; patient, fair, and untiring Chief Engineer; modest and devoted servant of your age and time,—I salute you as Honorary Member of this Association.

FRANK E. WINSOR. Mr. President, members of the Association, and friends: Until I heard this recital I did not realize that I had been guilty of so many crimes! I presume that Mr. Weston has verified the statements he has made, but I hardly recognized myself in the introduction. While he has attained great prominence and great success as a sanitary engineer I think perhaps he might have achieved even greater honors as a novelist.

It is a great honor and a great privilege to be elected an honorary member of this Association,—an association which probably has done as much for the engineer and for the superintendent in the water works field as any other association in the country, and certainly so in New England. I would say that up to some years ago it has been the leader and that it now divides this leadership with the American Water Works Association.

The associations which I had here in the city of Providence some years ago renders me particularly happy to receive this honor at this time. The city of Providence, you know, when they elect a good man as mayor, keep him in office. I came to Providence twenty years ago, and during all of this time there have been but two mayors,—Mayor Dunne, and his predecessor, Mayor Gainer, who was in office for many years.

I know that you do not want a speech from me. I just want to express my thanks to the Association for this great honor.

THE PRESIDENT. Mr. Stephen H. Taylor is the second man who has been made an honorary member. He was born in New Bedford on January 18, 1872, and attended the public schools of New Bedford. From 1888 to 1889, he was with A. B. Drake, civil engineer, who was then City Surveyor. From 1889 to 1904, he was in the superintendent's office of the New Bedford Water Works. From 1904 to 1906, he was in partnership with Frank C. Taylor, doing general contracting work, principally wharf and bridge construction and repairs. From 1906 to 1918, he was with the Associated Factury Mutual Fire Insurance Companies, Inspection Department, as an inspector. In 1919, he returned to the New Bedford Water Works as Assistant Superintendent, and in 1922, was elected Superintendent and Clerk, and is now serving in that capacity.

Mr. Taylor has presented the following papers before the New England Water Works Association: In 1922, Description of New Bedford Water Works System. In 1925, Machinery *vs.* Hand Labor in Pipe Laying. In 1931, Breaks in Water Mains. In 1935, Completing the Second 48-inch Force Main in New Bedford.

He has presented to the American Water Works Association a paper on Experience with the Use of DeLavaud Centrifugally Cast Iron Pipe. He has also presented articles in *Water Works Engineering* and *American City*.

Mr. Taylor is a member of the American Water Works Association and is at present chairman of the American Water Works Association Committee on Uniform Marking of Hydrants, and a member of the committee on Service Connections and Meters. He was instrumental in forming the New England Section of the American Water Works Association and was its first chairman and representative of the Board of Directors of the parent organization. He was formerly chairman of Plant, Management and Operation Division.

Mr. Taylor has served on the following New England Water Works Association committees: Diversion of Water Works Funds; Revision of Summary of Statistics; Bill for Protection of Water Works Superintendents; Cross-connections. He was president of this Association in 1924–1925.

Now, Mr. Taylor, in behalf of this Association, it gives me great pleasure to welcome you as an Honorary Member.

STEPHEN H. TAYLOR. Mr. President, ladies and gentlemen: I feel a good deal as Mr. Winsor did; I did not realize I have been such a bad actor in the past.

When I first received the notice that I had been elected to honorary membership in this Association I looked to see if it was spelled o-n-e-r-y, but fortunately it was not.

Seriously, I deeply appreciate this honor and thank the Association for it. I have always had a very warm spot in my heart for this Association since the days when I was a youngster and attended the meetings with Mr. Coggeshall, who was then secretary of the Association. That was along

in the '90s. We would see our friends from Nashua and Manchester in those days—Charlie Walker came from Manchester, and Horace Holden from Nashua. I remember well many of the old timers who were the charter members. I have always enjoyed the Association and am sure that I always shall.

I again thank you for the honor and assure you that I appreciate it very much.

Award of Dexter Brackett Memorial Medal.

The President. We have another honor for one of our members, and that is the award of the Dexter Brackett Memorial Medal. It has been awarded, this year, to Karl R. Kennison, Assistant Chief Engineer, Metropolitan District Water Supply Commission, Boston, for his paper: "Boston Metropolitan Water Supply Extension." The presentation will be made by William W. Brush, chairman of the committee on award.

William W. Brush. Mr. President, members and guests of the New England Water Works Association: At this time we are to do honor to two men. The first is your president of forty-five years ago—Dexter Brackett. I believe that with these awards we should give at least a moment to the consideration of the man in whose honor the award was established. Possibly as one of the very old-time members—not as old as some members here but among the old-time members—I perhaps feel more strongly on that subject than I should have felt thirty or forty years ago. When a man gives of his time and of his experience to the work in a certain field and to an association like this Association, that has so ably represented that field, it is very fitting upon his passing on that there should be some memorial established, and it was that feeling which actuated the members of this Association in establishing the Dexter Bracket Memorial Medal.

This award is now to be made to the man who presented the most meritorious paper that appeared during the preceding year in the Journal of the Association. Your committee made a unanimous decision as to the most meritorious paper, but that did not mean that it was a question of picking out only a meritorious paper because there were numerous meritorious papers in the 1934 Journal. The selection came to Mr. Karl R. Kennison, Assistant Chief Engineer of the Metropolitan District Water Supply Commission, and it came, I believe, as a result of the background of Mr. Kennison for the preparation of the paper, which prompted him to describe the work with which he has been connected in a manner that is not alone of passing interest as one reads the paper but in a manner that gives to each member of the Association information that is useful for the present and for the future in considering the engineering problems which are connected with that great work.

Mr. Kennison, a graduate of Colby in 1906 and of the Massachusetts Institute of Technology in 1908, started with an excellent background of

training. To that was added experience not alone in the water works field but in other engineering lines. He had the advantage of five years' work with that master of hydraulic engineering, our late friend and leader, John R. Freeman, and he served the city of Providence here for two years in connection with the design of the additional water supply. Then with experience as consulting engineer, also as engineer in lines allied with water works and other lines, he undertook, in 1926, the work with which he is now connected and designed the great system that is being constructed for the Boston Metropolitan District.

It is with great pleasure, Mr. Kennison, that I present to you this medal, and I congratulate you as well as the NEW ENGLAND WATER WORKS ASSOCIATION on the paper that you presented to the Association. The award of the medal represents work well done, and it is only because work of this character is done for the Association that the Association has been able to establish the very wonderful record that it has in the past. I con-congratulate you.

KARL R. KENNISON. Mr. President and Mr. Brush: I feel that an award of this sort is not so much an individual honor as it is a recognition of the importance and the size of our water supply project. Of course I could not write a paper of this sort without considerable help from a lot of other people, many of them members of this Association. I certainly appreciate the honor and am glad that the members have found the paper valuable.

Afternoon Session.

Secretary Gifford announced the election by the Executive Committee of the following new members:

Members.

Harry H. Angell, Deputy Superintendent, Water Department, Westfield, Mass.
James Frederick Brittain, Water Supply Commissioner, Braintree, Mass.
Charles Lyman Coburn, Metropolitan District Water Supply Commission, Boston, Mass.
Carter Stanard Cole, Engineer for Copper and Brass Research Association, New York, N. Y.
Charles B. Cole, Superintendent of Maintenance and Construction, Bristol County Water Company, Warren, R. I.
James J. Dillon, Assistant Sanitary Engineer, Rhode Island Department of Public Health, Providence, R. I.
Stanley M. Dore, Assistant Designing Engineer, Metropolitan District Water Supply Commission, Boston, Mass.
George F. Gardiner, Superintendant East Greenwich Water Supply Company, East Greenwich, R. I.
Thomas E. Harding, City Engineer, Pawtucket, R. I.
Charles F. Jost, New York, N. Y.
Adolph LaFleur, Superintendent of Pumping and Filtration, Bristol County Water Company, Warren, R. I.
Albert J. Lamarre, Commissioner of Public Works, Pawtucket, R. I.
Arthur O. Lavalley, Superintendent of Water Works, West Warwick, R. I.
John W. Logan, Superintendent of Water Works, Pawtucket, R. I.

Edward A. McLaughlin, M.D., State Director Rhode Island Department of Public Health, Providence, R. I.
William J. C. Marshall, Superintendent of Water Works, Georgetown, Mass.
Raymond Edwin Snow, Assistant Engineer, Springfield Municipal Water Works, Springfield, Mass.
Joseph Palmer Wadhams, Engineer, Connecticut Public Utilities Commission, New Haven, Conn.
Lewis Lumber Wadsworth, Engineer and Manager, Boston, Mass.
Joseph Wuraftic, Assistant Sanitary Engineer, Rhode Island Department of Public Health, Providence, R. I.

Associates.

Brainard & Hatch, Manufacturers of Meter-Master, Hartford, Conn.
The Foxboro Company, Foxboro, Mass., Manufacturers of Meters, Thermometers, and Controllers.
Hedge & Mattheis Co., Sales and Rent of Construction and Water Works Equipment, Boston, Mass.
Industrial Chemical Sales Company, New York, N. Y.
W. C. Lipe, Inc., Mechanical and Electrical Devices, Syracuse, N. Y.
Merrimac Chemical Company, Chemical Manufacturers, Boston, Mass.
Syntron Company, Manufacturers of Electric Tools, Pittsburgh, Pa.

A paper "Recent Developments in Connection with the Providence Water Works" was read by Philip J. Holton, Jr., Superintendent, Scituate Reservoir Division, Providence, R. I.

A paper "Ten Years of Sanitary Improvements in Rhode Island Public Water Supplies," prepared by Charles L. Pool, Sanitary Engineer and Chemist, and James J. Dillon, Assistant Sanitary Engineer, Rhode Island State Department of Public Health, was read by Mr. Pool.

Elson T. Killam, Consulting Engineer, New York, N. Y., read an abstract of "Report of Committee on Coefficients of Friction in Pipe Lines." The report was discussed by Messrs. Malcolm Pirnie, Edgar K. Wilson, Clinton Inglee, Gordon M. Fair, Charles W. Sherman, Warren J. Scott, William W. Brush, and George E. Russell.

A paper "Emergency Protection of Water Supplies During July Floods in New York State" was read by A. F. Dappert, Principal Sanitary Engineer, Division of Sanitation, New York State Department of Health. Warren J. Scott and E. Sherman Chase took part in the discussion.

In the evening a smoker was held, by courtesy of the Water Works Manufacturers Association, entertainment being furnished by professionals and by members and associates of the NEW ENGLAND WATER WORKS ASSOCIATION.

Wednesday, September 18.

Morning Session.

A paper "Providence Water Treatment" was read by Elwood L. Bean, Chemist, Providence Water Works. The paper was discussed by Warren J. Scott.

A paper "Recent Progress in Supplying Less Corrosive Soft Waters" was read by Malcolm Pirnie, Consulting Engineer, New York City. Elwood L. Bean, George Norcom, and Attmore E. Griffin took part in the discussion.

A paper "The New Salem-Beverly Filter Plant" was read by Frank A. Marston of Metcalf & Eddy, Consulting Engineers, Boston, Mass. W. Guy Classon discussed the paper.

An abstract of a paper "Water Supply Problems in the Tropics of Spanish America," written by George C. Bunker, Consulting Engineer, Ancon, Canal Zone, was presented by Theodore Reed Kendall, Engineering Editor, The American City Magazine, New York City.

The morning session was followed by a motor trip to the Scituate Reservoir and filter plant of the Providence Water Works. Luncheon was served at the filter plant, by courtesy of the Providence Public Works Department. The afternoon was spent in inspection of the Providence Water Works.

In the evening a boat trip on Narragansett Bay, with dancing on board, was enjoyed by members and guests through the courtesy of the Water Works Manufacturers Association.

Thursday, September 19.

Morning Session.

Reports of the committees on Specifications for Cast Iron Pipe and Special Castings, Standardization of Pipe Flanges and Fittings, and Manhole Frames and Covers were read by William R. Conard.

It was voted that the Committee on Manhole Frames and Covers be discontinued and that its work be turned over to the Sectional Committee on Flanges and Pipe.

A paper "Public Ground Water Supplies in Massachusetts" was read by Francis H. Kingsbury, Senior Assistant Engineer, Massachusetts Department of Public Health. The paper was discussed by Roger G. Oakman and Paul F. Howard.

A paper "Determining the Yield and Quality of Water from Tubular Wells by Means of the Well Rater and Sampler" was read by Paul F. Howard, of Whitman & Howard, Consulting Engineers, Boston, Mass. The paper was discussed by Stanley M. Dore.

A paper "The Water Supply of a Public Institution," was read by Bayard F. Snow, of X. H. Goodnough, Inc., Consulting Engineers, Boston, Mass. The paper was discussed by Paul F. Howard.

A paper "Geological Features in New England Ground Water Supply," was read by Kirk Brayan, Associate Professor of Physiography, Harvard University, Cambridge, Mass., and discussed by Henry T. Gidley.

A paper "Procedure in Developing Ground Water Supplies by Shallow Driven Wells" was read by Ralph Horne, of Fay, Spofford & Thorndike, Consulting Engineers, Boston, Mass. This paper was discussed by Harry W. Clark, Robert Spurr Weston, and Bayard F. Snow.

Colonel Willard G. Chevalier, Vice President, McGraw-Hill Publishing Company, discussed the present status of the Works Progress Administration and presented the following set of resolutions for discussion and adoption:

Whereas, the news reports indicate that the major portion of the federal funds to be expended on non-federal public works projects probably will be administered hereafter by the Works Progress Administration under its regulations and restrictions, and

Whereas, the funds remaining to be expended on such projects by the Public Works Administration will be subject to new and more restrictive regulations as to approval of projects and conditions of employment, and

Whereas, many communities now are in need of improved water works facilities and are willing to proceed with their construction using federal aid under the Public Works Administration regulations that have prevailed hitherto, and

Whereas, such projects require for their safe and adequate construction the services of many experienced engineers, competent supervisors, and skilled workmen and involve the installation of important structures, machinery and equipment, and

Whereas, the use of unskilled workers, incompetent supervisors and inexperienced engineers or the installation of inferior materials, machinery or equipment would cause not only waste and inefficiency but also a distinct public hazard from floods, epidemic or conflagration, and

Whereas, the revised regulations as to wage rates, total expenditures per man hour, number of skilled workers and selection of supervisors are not conducive to the selection and installation of trustworthy materials and equipment or the employment of sufficient competent workers and supervisors to insure sound workmanship, and

Whereas, if these regulations were amended many thousands of competent workers now unemployed would find employment on such projects and in the production and installation of such materials and equipment, and

Whereas, employment in such manufacture of materials and equipment will occur in large part in the larger centers of population where unemployment now is a maximum

Therefore, be it resolved by the New England Water Works Association, assembled in annual convention, that the President of the United States be requested and urged to establish suitable regulations to govern the administration of federal aid to non-federal water works projects so as to insure:

(a) The prosecution of many such projects now available or readily made available in hundreds of communities.

(b) The employment of competent engineers, supervisors and workmen on such projects regardless of whether they are on relief rolls and in proper proportion to insure first grade workmanship.

(c) The purchase and installation of materials and equipment on a basis of quality and performance that will insure trustworthy operation of such facility and full protection for each community against failures of structures or equipment that might endanger the health or safety of its people."

After discussion it was voted unanimously that the resolutions as read be adopted.

Afternoon Session

Presentation of Certificates of Award to Superintendents, Registrars and Commissioners.

The President. In this session we are going to present certificates of award to water works superintendents, registrars, and commissioners, who have served the same municipality for twenty-five years or more and who have been members of the New England Water Works Association for at least that number of years. Employees of private companies are not included.

The President then presented certificates as follows:

Horace Kingman, Superintendent and Commissioner of Water Works, Brockton, Mass.; member of the Association since 1893; entered the water department of Brockton in 1893 as Commissioner and Superintendent; born in Brockton in 1864.

Arthur E. Blackmer, Superintendent of Water Works, Plymouth, Mass.; member of the Association since 1908; entered Plymouth Water Department as Superintendent in 1902.

James W. Blackmer, Commissioner of Public Works, Beverly, Mass.; member of the Association since 1899; with the Beverly Public Works Department since 1892; 1892 to 1897 on engineering work for the water department; 1897 to 1914, Superintendent of Water Works; 1914 to present, commissioner of Public Works; born in 1869 in Plymouth, Mass.; graduated from the Massachusetts Institute of Technology in 1891.

A. W. F. Brown, Registrar and Superintendent of Water Works, Fitchburg, Mass; member of the Association since 1887; entered Fitchburg Water Department in 1883; appointed Registrar in 1885 and Superintendent in 1910.

Leland G. Carlton, Registrar of Municipal Water Works, Springfield, Mass.; member of the Association since 1907; entered Municipal Water Works of Springfield in 1906.

Thomas J. Carmody, Water Works Commission, Holyoke, Mass.; member of the Association since 1907; Commissioner since 1907.

Fayette F. Forbes, Superintendent of Water Works, Brookline, Mass.; member of the Association since 1885; Honorary Member 1929; President 1898–1899; entered Brookline Water Department in 1873; appointed Superintendent in 1875.

Patrick Gear, Superintendent of Water Department, Holyoke, Mass.; member of the Association since 1913; entered Holyoke Water Department in 1897; from 1897 to 1903, machinist in charge of meters, gates, and hydrants; 1903 to 1910, general foreman; 1910 to 1913, Assistant Superintendent; 1913, to present Superintendent; born in Ireland; came to America in 1879.

David A. Heffernan, Superintendent of Water Service, Milton, Mass.; a member of the Association since 1902; President 1923–1924; entered

Milton water service in 1902 as Superintendent; with Milton Water Company from 1890 until 1902, when the Water Company was purchased by the town; worked for the private company as service installer, meter reader, and assistant in the office; born in Dedham, Mass., in 1869.

THE PRESIDENT. The next man I find is myself. I have been a member of the Association since 1907 and with the department in Springfield since 1905.

Samuel H. MacKenzie, Engineer and Superintendent of Water Department, Southington, Conn.; member of the Association since 1903; Engineer and Superintendent of Southington Water Department since its beginning in 1911; Superintendent of Southington Water Company from 1908 to 1911, when the town purchased the company; born in 1877 in Meriden, Conn.; a resident of Southington since 1879; graduated from Huntsingers Business College, Hartford, Conn., in 1897.

William A. MacKenzie, Engineer and Superintendent Water Department, Wallingford, Conn.; member of the Association since 1908; with the Wallingford Water Department since 1910.

Hugh McLean, Water Commissioner, Holyoke, Mass., member of the Association since 1904; Commissioner since 1904.

William P. Molis, Superintendent of Water Works, Muscatine, Ia.; member of the Association since 1887; entered Muscatine Water Department as Superintendent in 1900 when the city purchased the water works; from 1876 to 1900 Superintendent for the private company.

John W. Moran, Superintendent of Water Works, Gloucester, Mass.; member of the Association since 1901; with the Gloucester Water Works since 1884, the date of construction; appointed Superintendent in 1891.

William Naylor, Superintendent and Registrar, Maynard Water Department, Maynard, Mass.; member of the Association since 1905; with Maynard Water Department since 1905 as Superintendent and Registrar.

Oren E. Parks, Superintendent, Board of Public Works, Westfield, Mass.; member of the Association since 1904; from 1893 to 1910 Town Engineer in Westfield; 1921 to the present Superintendent of Public Works in Westfield; graduate of the Massachusetts Institute of Technology in the class of 1893.

Percy R. Sanders, Superintendent of Water Works, Concord, N. H.; member of the Association since 1907; President in 1923; Superintendent since 1907.

Ernest J. Titcomb, Water Commissioner, Leicester, Mass.; member of the Association since 1910; Commissioner since 1910.

Leonard C. Robinson, Superintendent, Water and Sewer departments, Concord, Mass.; member of the Association since 1904; Superintendent of Water and Sewer departments, Concord, since 1906.

PATRICK GEAR. Members of the NEW ENGLAND WATER WORKS ASSOCIATION and friends: The getting of this certificate means more to me than it does to a great many people. When I was a young chap, the first day

I ever hired out to a farmer he asked me what pay I wanted, and I told him I would work six months "and you pay me what I am worth." I was never sorry for that. When I entered the Holyoke Water Department thirty-eight years ago next November there were four commissioners, and three of those are there now. In those thirty-eight years there was never a man that lost his job through politics. All they wanted him to do was to attend to his duties and mind his business. No man was ever fired. If a man retired—and quite a few did—that was the only change we had in the water department in Holyoke. That is the reason why I think we have a department that we are all proud of. You could not have that kind of thing if you were changing commissioners every year and with every administration.

Before I entered the water department I was contented where I was working in the Hadley Thread Machine Company. The Holyoke water commissioners at that time were looking for a chap to operate their machine shop. A friend of mine suggested me for the position. I got the job.

I was working in the Hadley mill and had an apartment in the Hadley block, and if I left the mill I couldn't have the flat. My boss, however, fixed it up so I could leave and work for the water department and keep my apartment in the Hadley block.

My position has been raised from time to time but I have never asked for an increase in pay. I was always advanced along according as the commissioners thought I was worthy of it. That is the policy in Holyoke. They never go outside of the department to get anyone if they have anyone in the department that they think can fill the job.

You should give credit to the commissioners who do not change, who do not have anything to do with politics, who do not ask whom you vote for; and if you run against them it makes no difference; they don't interfere. I am proud to be working for such a board, and I am proud of getting this certificate. The only water commissioners who can have a superintendent who can get it are water commissioners who do not interfere with him so long as he attends to his job, and when he passes away they have a big eulogy over him. I am glad I got this certificate before I passed away.

THE PRESIDENT. I hope you will have it a long time before you pass away, Pat.

DAVID A. HEFFERNAN. Thank you. Like Mr. Gear, I say that I am very much pleased at receiving a certificate in recognition of long service. I feel younger than the number of years I have been in the water service, now forty-five years. But if my health remains good I would like to continue a little longer. I enjoy my membership in the Association. I have been active in the Association, attending meetings and listening to the practical discussions, and I know I have benefited a great deal. That is the reason why I say to the water commissioners present today that they should do everything to get their superintendents to these meetings. When I first joined the Association I paid my way to the meetings and to the conventions, but I got on my board afterwards utility men as commissioners, and

I put the question right up to them, and they said, "Here, you go ahead and go to these conventions; the town is going to be benefited by it, and you put in your expense bill." I have been doing that for a good many years. My assistant is also a member of the Association. There ought to be more of that. What you learn from the engineers and from the superintendents that have had practical experience is going to be beneficial in running your department.

I want to thank you for this certificate, and I feel very proud.

Samuel H. MacKenzie sent this message:

I regret extremely that on account of the illness of Mrs. MacKenzie, who has always been such a help to me through all the years, I will be unable to be present at our convention this year, especially as the Association has seen fit to honor certain members who have seen long service in their respective positions in the water works field.

Any honor that has been bestowed in the past by the NEW ENGLAND WATER WORKS ASSOCIATION has not been an empty honor but one that was worth laboring for. I feel the same today in regard to the recognition which the Association is taking of certain members who have been employed for twenty-five years or over in the same position.

Personally I feel that I have done nothing meriting special attention as I have done nothing great or grand, of special importance to the world at large. I have just tried to fill the niche in which I was placed. I feel it was a special privilege to have been permitted to have charge of the water plant at Southington which was planned and built by my father and supervised by him for about twenty-five years prior to my becoming superintendent.

The years have shown the great value of the careful planning and conscientious supervision which my Scotch father and my uncle John M. MacKenzie, who were members of this Association, gave the construction of the plant, and I hope their good example has not been in vain.

I have considered my work a God-given task and trust the service rendered my Maker through my service to the community has in some small way, helped to make my community a healthier, better place to live in and life there happier and more in accordance with His plan. I thank you.

HUGH MCLEAN. Thank you, Mr. President and gentlemen of the Association. I can assure you that I have been benefited much by my membership in this organization, coming to its meetings for so many years, hearing the many good talks and making contacts that have been very, very beneficial in my life. I hope our Association will continue to prosper and flourish for twenty-five years and on. I can vouch for what Mr. Gear said. Once in a while it may be that politics creeps into your department, and the only thing to do is to jump on it and to fight for something you know should be done. I remember recently we had a member of the board of aldermen who used to introduce orders to investigate the water department. We thought if we gave him all the rope he wanted he would hang himself. One day he came in and said, "What did you send Mr. Gear to the World's Fair at Chicago for?" Mr. Carmody said, "He wasn't sent to the Worlds Fair; he was sent to a convention." He says, "Well, we think he is pretty old to be sent to a convention and that he is pretty old to be superintendent." Mr. Carmody said, "Well, we don't think he is too old. And, furthermore,

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we think he is better physically, mentally, and morally than you will ever be."

A paper "Income from Water Main Extensions" was read by Horace J. Cook, Superintendent, Auburn Water District, Auburn, Maine. The paper was discussed by Charles W. Sherman.

Sidney S. Anthony, Superintendent and Engineer, Augusta Water District, Augusta, Maine, read a report made by E. P. Noyes, director of safety, to George S. Williams, vice president and general manager of the Central Maine Power Company, of an investigation of an accident by asphyxiation and two successful resuscitations, that occurred at Bridge and State Streets, Augusta, on August 28, 1935.

A paper "Remodelled Pumping Station and New Diesel Engine at Nashua, New Nampshire," was read by William F. Sullivan, President, Pennichuck Water Company, Nashua, New Hampshire. The paper was discussed by William W. Brush, A. O. Doane, George F. Merrill, Percy R. Sanders, H. T. Gidley, and William Naylor.

A paper "New Booster Service System of Augusta Water District" was read by Sidney S. Anthony, Superintendent and Engineer, Augusta Water District, Augusta, Me. The paper was discussed by Roger W. Esty and William W. Brush.

A paper "Proportional Feeding Methods for Ferric Chloride and other Coagulants" was read by Rudy P. Lowe, of Builders Iron Foundry, Providence, Rhode Island.

Moving pictures showing the Manufacture of Transite Pipe were presented by C. A. McGinnis, Manager, Transite Pipe Department, Johns-Manville Corporation, New York City.

The matter presented by Mr. McGinnis was discussed by William A. MacKenzie, and David A. Heffernan.

A discussion of the rights of utilities in the public streets was opened by David A. Heffernan and discussed by Joe Smith, William F. Sullivan, Edmund C. Sanderson, and President King.

In the evening a dinner dance was enjoyed through the courtesy of the Water Works Manufacturers Association.

Friday, September 20.

Morning Session.

Resolutions.

Arthur L. Shaw. Mr. President, may I suggest that the members rise in honor of the members who have passed away during the past year?

[The members rise, in response to Mr. Shaw's suggestion.]

E. Sherman Chase. Mr. President and gentlemen: It seems to me that this convention has been one of the most outstanding conventions of recent years. Much of the success of the convention has been due to the coöperation of the officials of the City of Providence, to the local entertain-

ment committee and to the Water Works Manufacturers Association through their officials.

It seems to me that we should express our appreciation of these efforts in the form of a rising vote of thanks to the City of Providence through its Mayor and Commissioner of Public Works Maguire, to the local entertainment committee through Mr. Getchell, its chairman, and Mr. Pool, its assistant chairman, and to the ladies' entertainment committee through Mrs. Pool, and to the Water Works Manufacturers Association through its president, Mr. Norton.

I offer that as a motion.

PAUL F. HOWARD. Mr. President, I wonder if Mr. Chase will accept an extension of the motion to include the generosity of the press in giving us space?

MR. CHASE. I will accept the amendment.

[The motion was unanimously adopted by a rising vote.]

President King read the Report of the Finance Committee (See p. 457).

On motion, duly made and seconded, it is voted after discussion that the report be adopted.

Discussion of the Topics: Taste and Odor Control of Open Reservoirs by Use of Copper Sulphate; Collection of Delinquent Accounts in these Unsettled Times, was led by Harold L. Brigham, and participated in by William W. Brush, E. Sherman Chase, Donald C. Calderwood, Percy R. Sanders, Percy A. Shaw, Hugh McLean, Linn H. Enslow, E. T. Cranch, David A. Heffernan, Theodore L. Bristol, Roger G. Oakman, and L. G. Carlton.

Discussion of the Topic: Use of Water Supply Reservations for Recreational Purposes, was led by Harold L. Brigham, and participated in by Leslie K. Sherman, William W. Brush, Mr. Taylor of Chicopee, E. Sherman Chase, Elwood L. Bean, and Linn H. Enslow.

Discussion of the Topics: When Meters are Repaired and Cleaned, should they be Tested at Intermediate Rates of Flow as well as at Maximum and Minimum Rates? and In using 16-foot and longer Lengths of Cast Iron Pipe, what have been the Advantages or Disadvantages that you have found compared with using the 12-foot lengths of Cast Iron Pipe? was led by William W. Brush, and participated in by Roger W. Esty, David A. Heffernan, Fred E. Ellis, P. K. Wilson, George F. Merrill, Linn H. Enslow, Percy R. Sanders, Harold L. Brigham, E. T. Cranch, Percy A. Shaw, H. A. Hoffer, James M. Sweeney, William F. Sullivan, and Mr. Tally of Pennsylvania.

Discussion of the Topic: Service Pipe Problems, a discussion of leaks, methods of repair, methods of clearing old services, etc., was led by William B. Duffy, and participated in by David A. Heffernan, Roger W. Esty, Howard M. King, William W. Brush, Harold L. Brigham, E. T. Cranch, Linn H. Enslow, and Arthur C. King.

Discussion of the Topic: Water Works Operating Practice was led by Albert A. Ross, and participated in by Roger W. Esty, William W. Brush, David A. Heffernan, Mr. Taylor of Chicopee, Harry U. Fuller, and L. G. Carlton.

Report of Tellers of Election.

Number of ballots cast	212
Blank	2
Ballots counted	210
For President, ROGER W. ESTY	207
For Vice President, WARREN J. SCOTT	207
For Director, HAROLD K. BARROWS	204
For Treasurer, LELAND G. CARLTON	203

Respectfully submitted,

JOHN P. MILLER,
HAROLD L. BRIGHAM,
ARTHUR C. KING,
Tellers.

PRESIDENTIAL ADDRESS.

By Howard M. King.*

This convention is the fifty-fourth since the founding of this Association, and we have made much progress in this time, growing from a small beginning to our present considerable membership. However, we must endeavor to make this Association better and more useful each year, and to keep on growing and not rest on the laurels won in the past. There is a vast field in front of us to develop, and it will take the best efforts of the entire Association to cover it and keep abreast of the times. Mr. Chase, in his presidential address last year, pointed out that since 1929 our membership list had shown a decrease every year, but that it seemed we were about to start on the up-swing of our membership curve. Although the Secretary's report for 1934–1935 shows a loss of fourteen members, Mr. Chase's prediction has virtually been borne out inasmuch as the loss shown in the Secretary's Report is due to the dropping of forty-one members for non-payment of dues. Had the Executive Committee not dropped these forty-one members, our membership during the past year would have shown an increase of twenty-seven. Actually that increase exists, as all the members dropped were from two to five years in arrears and consequently even last year they were only names on our membership list rather than actual members. It is always hard to drop members in arrears, and this has only been done after having written such members several letters and having received neither part payment of their outstanding dues, nor requests for extension of time.

Annual Convention. This year our Executive Committee and the Executive Committee of Water Works Manufacturers' Association, in order to work together in full harmony in regard to the Annual Convention, have agreed to the following set-up, called a Board of Coördination:

The Board of Coördination consists of:

The President of the New England Water Works Association.
The Secretary of the New England Water Works Association.
The Chairman of the Program Committee of the New England Water Works Association.
The Chairman of Exhibits of the Water Works Manufacturers' Association.
The Chairman of the Entertainment Committee of the Water Works Manufacturers' Association.

These various officers of the New England Water Works Association and the Water Works Manufacturers' Association have met and decided on all the details of the Convention, and it certainly has been a pleasure to me to see the good will and disposition of both sides to get together for the best interests of the Convention and to make the Convention a success.

*Retiring President.

Certificates. It has been suggested that in these times of so much political activity, when so many trained Water Department employees are dismissed and their places filled with men who have no experience in Water Works management, that all superintendents, registrars and commissioners belonging to our Association for twenty-five years or more, and who have been for twenty-five years or more with one municipally owned Water Department, be commemorated for their loyalty and devotion to duty. In order to honor such members, we are, beginning this year, presenting them a suitable certificate. Certainly there is no denying the fact that the health and life of a community is bound up in the way the Water Department is handled, and the ones in charge with keeping such men in their positions deserve the greatest commendation for their judgment. The presentation of these certificates has been confined to employees of Municipal Water Departments for the reason that it seems to be a proven fact that owners of private water companies can be depended upon to keep in their employ men who have shown themselves capable of properly administering the water supply for which they are responsible.

Committees.

Committee to Collect and Tabulate Statistical Data.—Personnel: Richard H. Ellis, Chairman, E. Sherman Chase, Arthur D. Weston.

Purpose: To compile by means of the questionnaire composed by the Committee on Summary of Statistics, and with the help of the Unemployment Bureau of the Engineering Societies of New England, statistical data regarding:—Organization of Water Departments, operating methods, operating costs, sanitary scoring treatment, so that the statistics may be on hand at the headquarters of the Association for the use of members.

It is hoped that all members will carefully and promptly answer the questionnaire which should be out some time in September.

Committee on Technical Data. Personnel: Karl R. Kennison, Chairman, Frank A. Barbour, Arthur L. Shaw.

Purpose: To propose subjects for which technical data should be collected and for which work a committee should be appointed.

Committee on Algicides. Personnel: Prof. Gordon M. Fair, Chairman, Dr. Frank E. Hale, Warren A. Gentner.

Purpose: To investigate the matter of Algicides and the practical aspects of their application.

Deaths. During the year September, 1934 to September, 1935, seventeen of our members have passed away. Among these were X. Henry Goodnough, Honorary Member, Henry C. Meyer, Honorary Member, Frank E. Merrill, former President, Burt Hodgman, Chairman of Entertainment at Conventions, who took a prominent part in the affairs of this Association. It is sad to lose so many members who have always taken so great an interest in our Association, and to lose their valuable friendship.

Dexter Brackett Medal. The Dexter Brackett Medal has been awarded this year to Karl R. Kennison, Assistant Chief Engineer, Metropolitan District Water Supply Commission, Boston, who wrote the paper "Boston Metropolitan Water Supply Extension" published in June, 1934. This paper was considered the one of most value to the Association, of all the many good papers submitted.

Finances. The Association has not quite worked within the budget as laid out, but our finances are in a healthy condition. A detailed statement is given in the Treasurer's and Secretary's reports.

We have an invested fund on hand of $17 079.71, which is available in case of some future need. It is perhaps worthy of consideration if some limit should be set, after which the interest of the fund be used for purposes of expanding the aims of the Association; such as,—books for the library, for speakers on subjects of interest, for Water Works School not covered by registration fees, for defraying the expenses incident to the preparation of a decennial index to the JOURNAL, and also some clerical assistance in excess of normal, of special issues of the JOURNAL containing material of particular value to the Association, etc.

Journal. The JOURNAL this year carried nine new advertisements, bringing the revenue from advertisements up to $3 010, when last year it was $2 682. With the yearly cost of printing the JOURNAL at about $5,000, we are past the half-way mark toward making the JOURNAL self-supporting, and it is to be desired that eventually it will cover the cost of same. The JOURNAL is the principal interest of those members so situated that they are not able to attend the meetings, and every endeavor should be made to keep up the high grade of the papers printed therein, and also all that pertains to any advancement in the field of Water Works knowledge, so that all members may be able to know the latest ideas and practices that can be of value to the members of this Association.

It is to be hoped that more of our Manufacturer Associates will see the advantages of advertising in the JOURNAL, which is read by all members of the Association.

Legislation. Members of the Association were vitally interested in two bills this year which were introduced into the Legislature of Massachusetts:—namely, the Act relating to the shutting off of water for non-payment of bills only with the permission of the local boards of health, and the Act relative to licensing Diesel engine operators. There is no doubt that the action of the Association helped to keep both of these bills from being reported out of Committee, and in the case of the death of the first mentioned bill, we owe thanks to Mr. Gifford, our secretary, and for the second, the thanks are due to Mr. Donald Foster, Superintendent at Wilmington, Mass. This year we have arranged to receive regularly at the Association headquarters legislation bulletins for all the New England States so that members will be informed of all bills affecting Water Departments, and will be kept posted on the dates of hearing.

Honorary Members. Frank E. Winsor, who has been a member of this Association since 1900, was elected an Honorary Member for his eminence and outstanding ability. He is a Past President of this Association, and has always taken an active part in the affairs and councils of the Association.

Stephen H. Taylor, who has been a member of this Association since March 12, 1919, was elected an Honorary Member. Mr. Taylor is a Past President of this Association, and has at all times taken a very active interest in all matters pertaining to its advancement.

Meetings. Besides our regular meetings in Boston, which have been well attended, a very enjoyable meeting was held in New London, Conn. This meeting showed the great interest it attracted, especially from members in Connecticut and Rhode Island, who are seldom able to come to the regular meetings held in Boston. Great credit is due to Warren J. Scott and all his Committee for the valuable work they put in to make this meeting such a success. It seems to be a good idea to have one or two meetings a year outside of Boston, but within New England, to which the outlying members can attend more readily, and bring the advantages of these meetings to more people interested in the Water Works field.

A very enjoyable June outing was held in Provincetown, with a sail across the harbor, and dinner in Provincetown. Roger Esty and his committee made this outing very pleasant, and it was quite a departure from the usual June outing.

New Quarters. We have been a little over a year now in our new quarters in the Statler Building, where we have two rooms on the sixth floor. This makes it very handy for members in Boston and vicinity, and others that may be passing through, to drop in and get any information about the Association that they may desire. Miss Adelaide Ullian, the Assistant to the Secretary, is in attendance, and will be only too glad to be of assistance to all.

These rooms are much more attractive than those we had in the Tremont Temple Building, and it is to be hoped, as the Association grows, they will be utilized more and more.

Publicity. Whenever possible it is desirable that the public be informed through the newspapers of matters concerning our meetings and subjects of interest to the Association, that they may have an intelligent interest in our work, and that water works men who are not members will wish to become members. This is being done as far as possible now by Miss Ullian, Assistant to the Secretary, who has had valuable experience with newspapers in this line of work.

Superintendents' Round Table. The idea of former President Richard H. Ellis of this Association, that if before the regular meeting the superintendents of water departments and others interested got together and discussed topics of interest to them in the field of their duties, it would be of great interest and value, has been tried out with great success. The first room we had in the Statler Building was soon found too small, and so we then

had a larger room offered to us by the management of the Statler Building. These rooms have been furnished to the Association without cost, and on behalf of the Association, I wish to thank the manager of the Statler Building for this courtesy.

In my opinion these Round Table discussions should be made a permanent feature in the future, and with proper direction can be made of great value in many ways, not only for the ideas discussed but also the sociability that is found to ensue from getting acquainted more intimately with each other, as always happens in small gatherings.

Water Works School. This year the Water Works School was held in Portland, Me., in April, at the shops of the Portland Water District, where every convenience was placed at the disposal of the Committee. Twenty-two men attended the school.

There were instructors from Massachusetts Institute of Technology, Harvard Graduate School of Engineering and from the Portland Water District. Various subjects pertaining to water works interests were taken up and discussed.

The thanks of this Association are due to the Portland Water District and particularly to David E. Moulton, Esq., Clerk and Attorney, F. J. Reny, Treasurer, and Harry U. Fuller, Chief Engineer, for their successful planning and coöperation in the interest of the School, and to the professors of the colleges represented.

New Members. The work of securing new members which was taken up most vigorously by Roger Esty a couple of years ago, is still bearing fruit, and if each individual member would interest his associates in the matter, we would get along faster. This Association must advance by keeping its present members and getting new blood and ideas, and constantly striving to make the meetings of more value to the members.

Recommendations. It has been more or less the custom in the past for the retiring President to give his idea on what in his opinion would increase the usefulness of the Association. I have expressed most of my ideas in this address as I have gone along. The Round Table discussions are well worth following up and will, if handled right, augment the value of the meetings materially. The JOURNAL must be kept up to a high level and the papers abreast of all the latest ideas connected with the entire water works field. The Association should take more interest in public affairs that lie within our field, and endeavor to put the aims of the Association more prominently before the public, and especially the legislative bodies.

In closing I wish to express my thanks to the members of this Association for their helpfulness to me and to the different committees who have worked so hard to be of assistance, and also to Messrs. Chase and Gifford and Miss Ullian, who have given me so freely of their time and advice, and to the Manufacturers' Association, for coöperating so harmoniously with us on the Convention.

[Adjourned.]

Annual Report of the Secretary.

Mr. President and Gentlemen of the New England Water Works Association:— The Secretary submits herewith the following report of the changes in membership during the past fiscal year, and the general condition of the Association.

The present membership is 779, constituted as follows: 12 Honorary Members, 663 Members, 86 Associate Members, and 18 Corporate Members. The detailed changes are as follows:

MEMBERSHIP.

September 1, 1934.	Honorary Members	12			
	Withdrawals:				
	Died	2	10		
	Elected:				
	September, 1934		2		12
September 1, 1934.	Members, Total		670		
	Withdrawals:				
	Resigned	10			
	Died	15			
	Dropped by Executive Committee	31			
	Elected to Honorary Membership	1	57	613	
	Elected:				
	September, 1934	22			
	November, 1934	5			
	December, 1934	8			
	January, 1935	2			
	February, 1935	3			
	May, 1935	9		49	
	Reinstated:				
	September, 1934			1	663
September 1, 1934.	Juniors, Total		0		
September 1, 1935.	Juniors, Total		0		0
September 1, 1934.	Associates, Total		95		
	Withdrawals:				
	Resigned	5			
	Dropped by Executive Committee	10	15	80	
	Elected:				
	September, 1934			5	
	Reinstated:				
	December, 1934			1	86

September 1, 1934.	Corporates, Total	16	
	Elected:		
	February, 1935	2	18
September 1, 1935.	Total Membership		779
September 1, 1934.	Total Membership		793
	Net Loss		14

ELECTIONS.

Honorary Members.

September 18, 1934. Frank A. Barbour and William James Eames Binnie. (2)

Members.

September 18, 1934. John D. Annis, Anthony C. Benjes, Thomas J. Boland, Walter B. Bushway, William R. Clary, Louis B. Davis, Florence E. Driscoll, Gail P. Edwards, Wilbert C. Hardy, M.D., Francis L. Hatch, John J. Healy, Jr., Harold J. Lockwood, Charles A. Maguire, Arthur B. Marsden, Edward S. McCormick, Elias A. Mossey, Joseph J. Murray, James H. O'Connor, George G. Shedd, David R. Smith, Ralph A. Wheeler, and Charles F. Whitman, Jr. (22)

November 15, 1934. Jesse P. Carpenter, D. William Harford, George C. Houser, Earl E. Mooney, and Fred F. Parker. (5)

December 20, 1934. Gordon Campbell, Fred E. Ellis, Laroy G. Harris, Maurice A. Libby, C. Roger Pearson, John H. Read, Ernest J. Sullivan, and Lewis A. W. Swett. (8)

January 17, 1935. James P. Curtiss and James A. Sweeney. (2)

February 28, 1935. Philip J. Holton, Jr., Howard P. Shattuck, and Henry Wiesner, Jr. (3)

May 16, 1935. William R. Benford, Walter H. Chase, Harold Fox, Clinton Inglee, Charles B. Loomis, Paul Pazziani, Charles H. Tompkins, Robert P. Trask, and Harold S. Woods. (9)

Associates.

September 18, 1934. Johns-Manville Sales Corporation, Republic Steel Corporation, The Rogers Press, Raymond W. Sparling, and The Vellumoid Company. (5)

Corporates.

February 28, 1935. Board of Water Commissioners of Newburyport, Mass. and Board of Water Commissioners of Norwich, Conn. (2)

REINSTATEMENTS.

Members

September 18, 1934. Stuart E. Coburn.

Associates.

December 20, 1934. Walter W. Field & Son, Inc.

Resignations and Deaths.

Members.

Resigned: S. A. Agnew, N. J. Beisel, C. J. Clogston, A. D. Couch, John Cullen, J. A. Foulks, W. A. Hardenbergh, G. E. Newbury, M. M. O'Shaughnessy, and G. B. Raymond. (10)

Dropped for non-payment of dues: G. E. Barnes, R. B. Chalmers, Thorn Dickinson, C. F. Drake, J. D. Egan, R. H. Gould, J. W. Graham, W. M. Hatch, W. S. Hayward, M. S. Kaharl, J. J. Kapp, Jr., G. A. Lyons, D. L. MacDonald, H. F. MacWilliams, S. Nishioeda, F. B. Northrop, A. L. Pierce, A. A. Potenza, A. L. Pratt, F. H. Pitcher, E. B. Riley, M. J. Rutledge, G. W. Simons, Jr., J. F. Sullivan, Joseph F. Sullivan, W. A. Sancrie, W. A. Tucker, Jr., F. O. Walker, F. C. Williams, A. A. Woodford, A. A. Young. (31)

Died: W. F. Abbott, H. R. Buck, W. H. Burr, C. E. Durant, D. W. French, S. P. Gates, Burt Hodgman, W. C. Hopper, H. F. Huy, C. E. Kendall, A. H. Kneen, F. E, Merrill, Dwight Porter, F. N. Strickland, H. F. P. Wilkins. (15)

Honorary Members.

Died: X. Henry Goodnough and Henry C. Meyer. (2)

Associates.

Resigned: Baldwin-Southwark Corporation, Goulds Pumps, Inc., Joseph G. Pollard Co., Inc., Power Equipment Co., and Water Works Equipment Co. (5)

Dropped for non-payment of dues: American Active Carbon Corporation, Allen & Reed, Inc., Roy S. Barker, Morgan B. Main, Antonio Mogavero, Nelson Cement Stone Co., Inc., Paradon Mfg. Co., S. E. T. Valve & Hydrant Co., Sentry Mfg. Co., George H. Sampson Co. (10)

Receipts for the Fiscal Year, September 1, 1934 to September 1, 1935.

Entrance Fees			$245.00
Annual Dues:			
Members	$3 047.94		
Corporates	150.00		
Associates	1 580.00	$4 777.94	
Fractional Dues:			
Members	$ 83.50		
Corporates	13.00		
Associates	15.00	111.50	
Past Dues:			
Members	$ 291.50		
Associates	80.00	371.50	
1935–1936 Dues:			
Members	$ 27.00		
Corporates	5.00		
Associates	80.00	112.00	
Total Dues			5 372.94

Dividends		522.38
Advertisements		2 774.00
Subscriptions		573.00
JOURNALS		72.46
Sundries		552.39
Total Receipts		$10 112.17
There is due the Association:		
Dues	$900.50	
Advertisements	133.00	
JOURNALS	11.50	
Reprints	9.10	
Entrance Fee	3.00	
Electro	1.35	
Halftone	5.84	
Meter Rate Sheet	.25	1 064.54
Total		$11 176.71

Respectfully submitted,

FRANK J. GIFFORD, *Secretary.*

Annual Report of the Treasurer.

The President and members of the New England Water Works Association:—I herewith submit my report as treasurer for the year ending August 31, 1935.

Receipts.

Initiation Fees		$ 245.00	
Dues		5 372.94	
Interest		522.38	
From Publication of Journal:			
Advertisements	$2 774.00		
Subscriptions	571.00		
Sale of Journal	72.50		
Sale of Reprints	30.26	3 447.76	
Miscellaneous:			
Tuition, Water Works School	$ 204.00		
Membership Certificates	24.00		
Pipe Specifications, etc.	3.25		
Receipts for Outing	283.71		
Miscellaneous	7.13	522.09	
Total Receipts			$10 110.17

Disbursements.

Publication of Journal:			
Printing	$2 942.70		
Plates	454.24		
Reporting	382.58		
Reprints	335.35		
Stationery and Postage	104.20		
Advertising Agent's Salary and Commissions	50.00		
Editor's Salary	500.00		
Editor's Expense	1.35		
Telephone and Telegraph	2.33		
Sundries	8.00	$4 780.75	
Office and General:			
Certificates of Membership	$ 13.50		
Engineering Society of New England	501.58		
Assistant Secretary's Salary	1 319.94		
Secretary's Expense	21.43		
Treasurer's Bond	5.00		
Printing, Postage and Stationery	249.62		
Office Rent	1 200.00		
Electricity and Towel Service	34.95		
Telephone and Telegraph	166.39		
Audit	65.00		
Contributions	7.50		
Check Taxes and Exchange	3.01		
Sundry Supplies and Expense	405.16	3 993.08	
Forward		$8 773.83	$10 110.17

Brought Forward		$8 773.83	$10 110.17
Meetings and Committees:			
Badges	$ 31.78		
Medal	15.00		
Printing, Postage and Stationery	198.73		
Stereopticon	120.72		
Committee Expense	1.71		
Convention Expenses	147.15		
Water Works School	351.20		
Outing Expense	265.77		
Miscellaneous Expenses	24.74	1 156.80	
Total Disbursements			9 930.63
Excess of Receipts over Disbursements			$ 179.54
Balance, General Cash, August 31, 1934			295.95
Balance, General Cash, August 31, 1935:			
Represented by Cash in Bank		$ 425.49	
Represented by Cash in Office		50.00	
			$ 475.49

Treasurer's Report.

Statement of Assets and Funds.

As at August 31, 1935.

Assets.

Cash in Banks, Invested Funds:		
City Five Cents Savings Bank, Haverhill, Mass.	$2 000.00	
Farmers and Mechanics Savings Bank, Framingham, Mass.	2 068.46	
Franklin Savings Bank, Boston, Mass.	2 000.00	
Haverhill Savings Bank, Haverhill, Mass.	2 000.00	
Home Savings Bank, Boston, Mass.	1 011.25	
Mechanics Savings Bank, Reading, Mass.	2 000.00	
Pentucket Savings Bank, Haverhill, Mass.	2 000.00	
Peoples Savings Bank, Worcester, Mass.	2 000.00	
Suffolk Savings Bank, Boston, Mass.	2 000.00	
Total Invested Cash		$17 079.71
General Fund:		
Cash, First National Bank of Boston	$ 425.49	
Cash in Office	50.00	
	$ 475.49	
Furniture and Fixtures	1 113.50	1 588.99
Total Assets		$18 668.70

Funds.

Invested Funds		$17 079.71
General Fund:		
Balance, August 31, 1934	$1 409.45	
Excess of Receipts over Disbursements	179.54	
Balance, August 31, 1935		1 588.99
Total Funds		$18 668.70

Note: — The preceding statement is prepared on a cash basis and does not reflect the following:

Accounts Receivable, Dues		$ 900.50
Due on Account of Advertising and Other Miscellaneous Charges		164.04
		$ 1 064.54
Accounts Payable		$ 707.70
Dues Paid in Advance		160.00
		$ 867.70

No Depreciation has been taken on Furniture and Fixtures.

Respectfully submitted,

(Signed) Leland G. Carlton, *Treasurer*

Annual Report of the Editor.

To the New England Water Works Association: The Editor submits herewith the following report for the year ending August 31, 1935.

As has been customary in the past, the tables of financial figures, accompanying the report, are based upon total charges and accounts receivable, rather than actual cash received or disbursed. A detailed statement of the receipts and disbursements on account of the September and December, 1934, and March and June, 1935, issues of the Journal is included in the Report of the Treasurer.

Table 1 is a statement of the material published.

Table 2 gives a comparison of the Journal for the past year with preceding years.

Size. The four issues contained 643 pages, of which 470 were text.

Cost. The gross cost of the Journal was $4 780.75, equivalent to $6.08 per member; the net cost was $1 332.99, equivalent to $1.70 per member.

Reprints. Fifty reprints of each paper have been furnished to the author where desired.

Circulation. The present circulation of the Journal is:

Members, all grades	779
Subscribers	121
Exchanges	18
Total	918

(Journals have been sent to all subscribers.)

Respectfully submitted,

Gordon M. Fair, *Editor.*

Table 1.

Statement of Material in September and December, 1934, and March and June, 1935, Issues of the Journal of the New England Water Works Association.

Date.	Pages of.								
	Papers.	Proceedings.	Total Text.	Index.	Advertisements.	Cover and Contents	Insert Plates.	Total.	Total Cuts
September, 1934	117	11	128	0	35	5	0	168	11
December, 1934	77	31	108	9	35	5	0	157	41
March, 1935	103	15	118	0	36	6	0	160	23
June, 1935	106	10	116	0	36	6	0	158	39
Total	403	67	470	9	142	22	0	643	114

TABLE 2.

COMPARISON OF JOURNALS OF THE NEW ENGLAND WATER WORKS ASSOCIATION.

	FOUR ISSUES FOR FISCAL YEAR ENDING AUG. 31									
	1926.	1927.	1928.	1929.	1930.	1931.*	1932.	1933.	1934.	1935.
Average edition (copies printed)	1 100	1 100	1 138	1 200	1 350	1 260	1 200	1 125	1 100	1 100
Average membership	775	784	808	831	822	816	813	805	796	786
Circulation at end of year	906	916	955	993	980	955	957	930	928	918
Pages of text	523	492	528	507	570	410	437	420	499	470
Pages of text per 1 000 members	675	628	654	610	693	502	537	522	627	598
Total pages, all kinds	761	724	769	745	812	682	644	594	645	643
Total pages per 1 000 members	982	952	952	896	988	836	790	738	811	808
GROSS COST:										
Total	$6 524.62	$5 839.36	$6 849.44	$6 740.87	$8 054.59	$6 135.33	$5 024.03	$4 712.16	$5 411.30	$4 780.75
Per page	8.57	8.07	8.91	9.06	9.92	9.00	7.80	7.93	8.39	7.54
Per member	8.42	7.45	8.48	8.12	9.80	7.52	6.18	5.85	6.80	6.08
Per member per 1 000 pages	11.07	10.29	11.02	9.77	12.07	9.00	9.62	9.85	10.53	9.46
Per member per 1 000 pages text	16.10	15.13	16.06	16.01	17.19	18.34	14.30	13.94	13.62	12.93
NET COST:										
Total	$2 040.28	$710.63	$1 716.25	$1 857.58	$3 664.76	$1 252.21	$1 121.20	$1 176.77	$1 916.27	$1 332.99
Per page	2.68	.98	2.23	2.07	4.51	1.84	1.74	1.98	2.97	2.07
Per member	2.64	.91	2.12	2.24	4.46	1.53	1.38	1.46	2.41	1.70
Per member per 1 000 pages	3.47	1.26	2.76	2.50	5.49	2.24	2.14	2.46	3.73	2.64
Per member per 1 000 pages text	5.05	1.85	4.02	4.41	7.82	3.73	3.16	3.48	4.83	3.61

*Including Comprehensive Index, 1882 to 1930.

Report of Finance Committee.

Your Committee submits as its recommendation for 1935–1936 expenditures the following:

For the Journal	$ 4 500.00
For the Office	4 500.00
For Meetings and Committee	1 000.00
	$10 000.00

It is the belief of the Committee that the Association can keep within this budget only by taking affirmative action on the three following recommendations:

First: Discontinue the Free Reprint privilege now in effect on articles submitted to the Journal.

Second: Discontinue affiliation with the New England Society of Engineers.

Third: Allocate to the 1935–1936 receipts a sum (not in excess of $700.00) from invested funds.

The first recommendation is expected to effect a saving of $500.00 based on experience of the last ten years.

The second recommendation is expected to effect a saving of $300.00 this fiscal year ending September 1, 1936 and $500.00 a year thereafter.

The third recommendation seems to this Committee advisable in order that the practice of throwing over into the next fiscal year expenses that would make for a sizable deficit may be avoided.

These recommendations were arrived at after consultations with the Assistant Secretary and the Treasurer and represent our unanimous opinion after analysis of past expenditures and future needs.

Respectfully submitted,

Donald W. Foster,
George E. Watters,
John H. Read, *Chairman.*

September 12, 1935.

Report of Committee on Specifications for Cast Iron Pipe and Special Castings.

New England Water Works Association.

Gentlemen: Your Committee on Specifications for Cast Iron Pipe and Special Castings would report as follows:

Since the report of the Annual Convention in September, 1934, the various Sub and the Technical and General Committees have been active in trying to make an actual showing of things accomplished, and considerable work has been done.

The Annual Meeting of the Sectional Committee in April was largely taken up in Sub-Committee Meetings and getting Technical Committee work in shape for submission of matters to letter ballot.

Technical No. 1: Shearing Tests at Columbia University, and, Flow Tests at Cornell University. Findings have been approved.

Technical Committee No. 2: The elimination of the use of the word "Cinder Iron" and the substitution, therefor, of a sentence which reads: The metal in the pipe and fittings shall show by chemical analysis a Sulphur content of not to exceed 1/10 per cent, and a Phosphorus content not to exceed 9/10 per cent, was approved.

The ballots on Technical Committee No. 1 were then submitted to the Section Committee and have been approved by it. Also a ballot is still out for voting on Tentative Specifications for "Coal Tar Dip Coatings" and the final results not yet available.

The matter of Barrel of pipe thicknesses and of fittings is still quite active and if these can get to the point of adoption, the composition of the text of the Specifications and the work of getting out tables of dimensions should shape up rapidly.

The next few months should see this Sectional Committee work being worked to a head and with tentative Standard Specifications in sight.

Respectfully,

Chas. W. Mowry,
A. L. Shaw,
W. R. Conard, *Chairman.*

Supplementing the foregoing report there is attached a copy of a progress report furnished by Mr. A. V. Ruggles, Executive Assistant, after review by Mr. T. H. Wiggin, Chairman of Sectional Committee.

W. R. Conard.

Sectional Committee Progress Report.

Technical Committee 1—Dimensions.

Sub-Committee 1-A, Barrel of Sand Cast Pipe. Chairman Wiggin has submitted successive reports giving proposed schedules of thicknesses of pipe, of the kinds to be included in our specifications, and giving in complete detail his methods of arriving at these schedules using the knowledge and methods resulting from the trench load tests at Iowa State College and giving the figures for strength properties of pipe and fittings resulting from the committee's tests and adopted by him for use in the schedules. This has been followed by the submission by Mr. W. D. Moore of thickness schedules produced by somewhat different methods but arriving at nearly the same results and following the meetings of the committee last Spring work has continued uninterruptedly by Mr. F. H. Stephenson under Mr. Wiggin's direction on further computations with the object of adjusting the methods slightly to produce a schedule which will be satisfactory to all members of the committee on the score of both methods and results. This work is close to completion but at present is awaiting certain information requested from Mr. W. J. Schlick who has made the trench load tests for the committee at Iowa State College.

Sub-Committee 1-B, Bell and Spigot Dimensions of Cast Iron Pipe Including Lugs and Harnesses. Following tests of joints and harnesses this sub-committee decided to make no change in dimensions of bells and spigots and to prepare a pamphlet, separate from the specifications, illustrating recommended types of lugs and harnesses for use where necessary and of two or more kinds depending on whether it is or is not known in advance that such harness will be required.

Sub-Committee 1-C, Pipe Other than Pit Cast. This sub-committee is no longer functioning as a separate sub-committee, its work having been absorbed in Sub-Committee 1-A on Barrel of Pipe of all kinds.

Sub-Committee 1-D, Fittings. Successive reports have been issued by Mr. F. H. Stephenson under Mr. Wiggin's direction summarizing the results of strength tests on fittings and applying to them a recommended "groin stress" method of analysis, a method approximate but easily used. Mr. Stephenson has applied this to existing fittings and to those proposed for inclusion in the specifications. The manufacturers have been unwilling to accept this method as yet. Following the strength tests on fittings made by the committee the manufacturers made a series of similar tests on their own account and following the submission of Mr. Stephenson's reports the manufacturers have started and are still continuing a new series of strength tests on fittings. Matters therefore await the completion of these tests and a study of their results.

Technical Committee 2—Metallurgy, Processes and Tests.

Sub-Committee 2-A, Raw Materials and Melting Practice. No specification to be prepared by this sub-committee.

Sub-Committee 2-B, Metallurgy and Chemistry. This sub-committee has changed the old specifications, in regard to metallurgy and chemistry in two respects, first by limiting the phosphorus content to .90 per cent. and sulphur to .10 per cent., and second by specifying a method of drilling completely through from skin to skin a test specimen to obtain a sample for chemical analysis. These changes have been adopted by Technical Committee 2 and will be submitted to the Sectional Committee.

Sub-Committee 2-C, Physical Tests and Test Specimens. Successive drafts of the specifications for physical tests and test specimens have resulted in final specifications and a letter received very recently announces that unless objection is raised these specifications will be submitted shortly to the sub-committee for adoption.

Sub-Committee 2-D, Experience. No specifications to be prepared.

Technical Committee 3—Corrosion and Protective Coatings.

Sub-Committee 3-A, Theory of Corrosion of Cast Iron Pipe. No specifications to be prepared.

Sub-Committee 3-B, Organic Coatings. A tentative specification for coal tar dip coating has been adopted by the sub-committee and by Technical Committee 3. Specifications for other coatings will be prepared.

Sub-Committee 3-C, Inorganic Coatings. A tentative specification for cement mortar lining was adopted by the sub-committee, Technical Committee 3 and the Sectional Committee and submitted to the four sponsor societies. It was approved by the American Water Works Association and the American Gas Association and no report was received of action on it by the other two sponsor societies. Informally it was learned that a more technical specification was desired by at least some of their committeemen to whom the specification was referred by the Sponsor Societies. Such a specification providing for much closer control of materials and processes in the lining of pipe and fittings was presented at the meeting of Sub-Committee 3-C last April and was referred back to a small committee to thresh out differences between consumer and producer views. That small committee has been very actively engaged in this work during the past few months and is still so engaged with hope of completion in the not distant future. It is expected that the alternative specification will replace the earlier one.

Sub-Committee 3-D, Water Corrosion Experience. No specifications to be prepared by this committee.

Sub-Committee 3-E, Soil Corrosion. No specifications to be prepared by this committee.

Sub-Committee 3-F, Hydraulics. No specifications to be prepared by this committee.

BOOK REVIEW.

WATER QUALITIES AND MEANS FOR THEIR CORRECTION. (Qualités de l'Eau et Moyens de Correction.) By Edouard Imbeaux. Paper; 7½ x 11 in., pp. 823; photographs; diagrams and tables. Published by Dunod, Paris, France. Fr. 295.

It is not often that we have an opportunity to see a phase of engineering extensively compared from the international point of view. In this recent work by Dr. Edouard Imbeaux, we are afforded a most interesting opportunity to see this broad subject set forth not only as our practice goes in the United States, but also in France, England, Germany and various other parts of the world.

Dr. Imbeaux is Professor of Applied Hydrology of the Ecole des Ponts at Chaussées, of France, and is a member of the Supreme Council of Public Health of France. His broad interest in the water supply problem led him long ago to become a member of the American Water Works Association as well. As Adviser to the Minister of War of France, in matters pertaining to water supply, a responsibility which he held during the war and which he still holds, he is well known to many Americans who dealt in water supply problems with the A. E. F. His extensive knowledge of the hydrology of France was at the service of our Army and was indispensable to its welfare.

Dr. Imbeaux' earlier books on water supply, which include "Annuaire Statistique et Descriptif des Distributions d'Eau et Egouts" and "Essai d'Hydrogeologie," are classics. Now comes this new one on Qualities of Water and Means for their Correction.

In his efforts to present, for the benefit of French readers, the best experience in connection with American water supply work, the author has included much information which has long been every-day knowledge to American water works engineers. The interest which American engineers will find in this book, therefore, is chiefly in the extensive compilation of information of similar material from sources outside the United States and not commonly found in our literature. This, of course, will be welcome to many of us. Those interested in problems of water purification and the control of water quality will find this treatise broadly informative.

In that section of the book dealing with the methods of analyzing water, there is opportunity for a comparison of numerous different methods in use in different countries. Such comparisons, of course, have already been made extensively by laboratory workers in this part of the world, and the standard methods for water analysis of the American Public Health Association reflect much of this comparative study. The author's purpose does not seem to have been to make comparisons, since comparative results of different methods are not given, but in setting forth these numerous methods he has done a useful service to those who wish to make comparative studies of the suitability and efficiency of different methods.

In American technical literature, different features of the water supply problem are largely dealt with under separate cover by different authors whose work has led them to specialize in their respective fields. Here, however, we find the biological phase of the problem dealt with under the same cover with the chemical and the engineering phases of water supply work.

Likewise our literature has dealt with the water supply problem mainly from the point of view of public water supplies. The author, located in a part of the world where mineral water and mineral baths have for long been an important factor, devotes a considerable part of his volume to a discussion of this phase of the water supply problem.

The author describes a large number of proprietary filters. The extent and variety of this development in Europe is interesting. On the other hand, from the earliest days of the important development of water purification plants in this country, engineers in the employ of municipalities have studied the characteristics of their problems; have recognized a certain few elements as basic; have attacked these basic elements scientifically; and then, most important of all, have exchanged views freely, have coördinated

and unified their conclusions, and have made all this information public property to the great and lasting advantage of the country. Even those industries which specialize in the business of building water purification plants have been ponderously influenced by this policy and conform closely to it, so that their business today consists more in the furnishing of the special mechanical appliances needed in a filtration plant of conventional engineering design, than it does in furnishing the entire plant as a ready-made mechanical unit.

It is also interesting to note the large number of filters described by the author for domestic use, indicating a demand, or at least recognizing a need for means at the command of a household for purifying the water it uses; a need which has become less and less in the United States and Canada, owing to the public policy which has been pursued of making all municipal water supplies safe to drink.

Under the heading of Correction of Chemical Qualities of Water by the Removal of Oxygen, the story would have been made more complete by reference to one of the most classical cases on record, namely, the deaëration of the water which is pumped through the famous 350-mile Coolgardie pipe line in Australia, described in the Proceedings of the Institute of Civil Engineers, Vol. 162, Paper 3516, and also in this JOURNAL, December, 1925, page 421.

In pursuing inquiries in this unusual treatise, it is not always easy to put one's finger on the subject matter he wants, through the table of contents. In view of the author's effort to make this work comprehensive, its usefulness could have been increased if an index had been included.

On the whole, this work of Dr. Imbeaux' presents a most interesting opportunity for students of the water supply problem to study the art as it is practised in many parts of the world.

FRANCIS F. LONGLEY.

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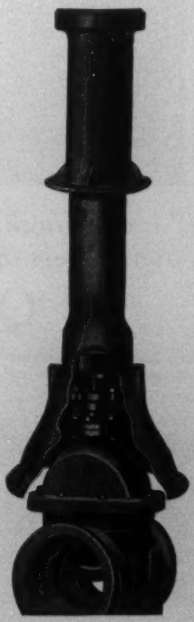

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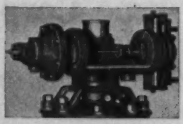

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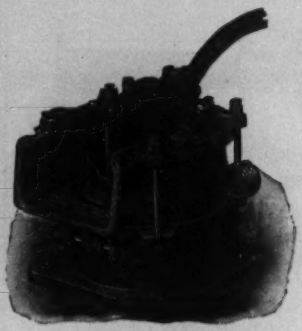

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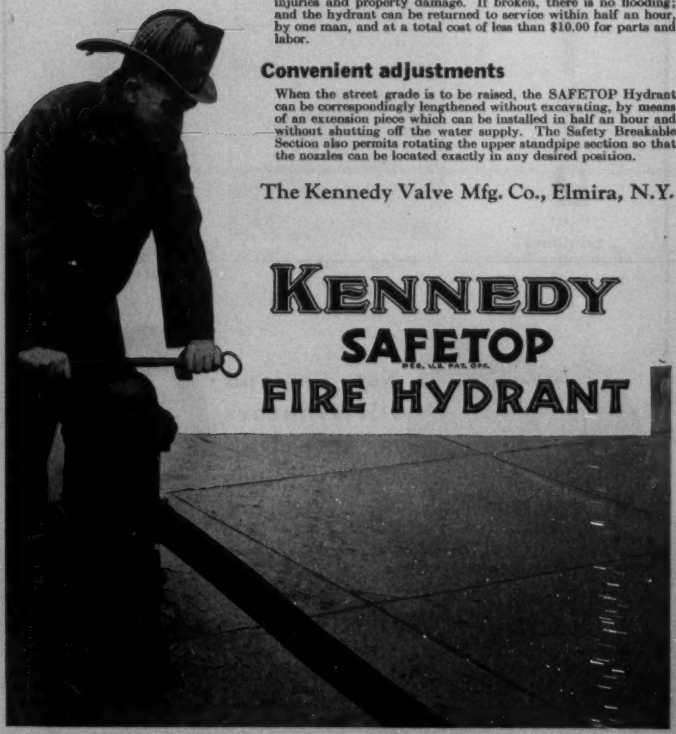

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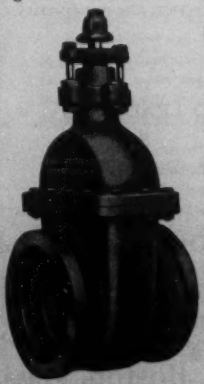

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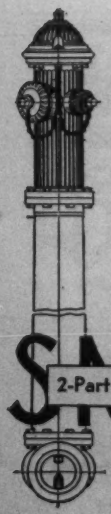

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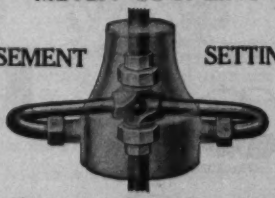

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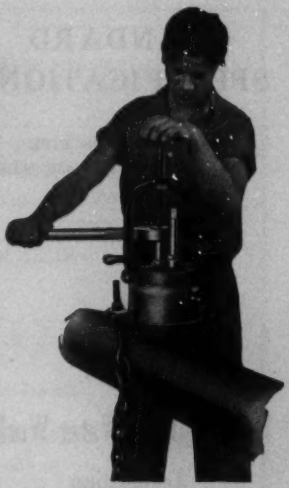

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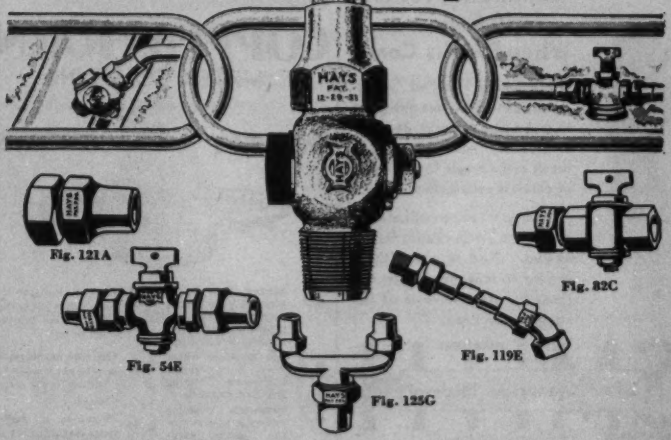

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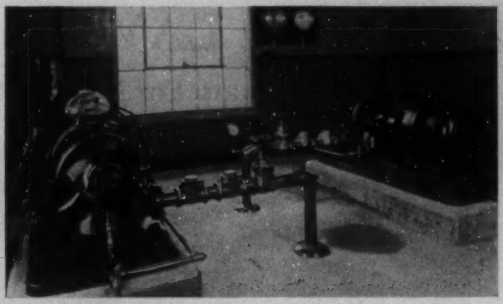

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W&T Visible Vacuum Chlorinators are described in Technical Publications 38, 157 and 158—any or all of which will gladly be mailed for the asking.

"The Only Safe Water Is A Sterilized Water."

WALLACE & TIERNAN CO., Inc.

Manufacturers of Chlorine and Ammonia Control Apparatus

NEWARK, NEW JERSEY Branches in Principal Cities...Main Factory, Belleville, N. J.

. . . and now the World's Best Cone Valves

Cone Valve Is Available for—

ALTITUDE CONTROL
PRESSURE REDUCING
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SLUDGE LINES
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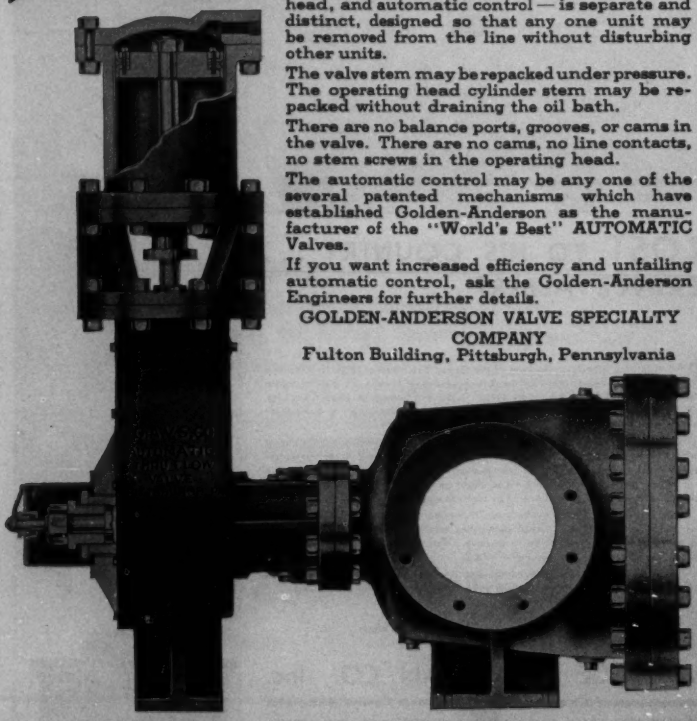
WORLD'S BEST AUTOMATIC Valves



For more than 30 years Golden-Anderson has been known as the manufacturer of the WORLD'S BEST AUTOMATIC valves.

Now, Golden-Anderson offers you the supreme development in the Thru-Flow or Cone type Valves.

In the new Golden-Anderson Thru-Flow Valve the plug is unseated axially, rotated, and reseated axially, all in one free and frictionless operating movement and drop tight in either open or closed position; this is accomplished by means of a simple and sturdy patented toggle type rotor mechanism which is encased in a bath of oil in the operating head.

The valve itself is just as simple and sturdy, the full flow plug being stronger than pipe of the same area.

And each unit — plug, valve body, operating head, and automatic control — is separate and distinct, designed so that any one unit may be removed from the line without disturbing other units.

The valve stem may be repacked under pressure. The operating head cylinder stem may be repacked without draining the oil bath.

There are no balance ports, grooves, or cams in the valve. There are no cams, no line contacts, no stem screws in the operating head.

The automatic control may be any one of the several patented mechanisms which have established Golden-Anderson as the manufacturer of the "World's Best" AUTOMATIC Valves.

If you want increased efficiency and unfailing automatic control, ask the Golden-Anderson Engineers for further details.

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REG. U.S. PAT. OFF.

BITUMASTIC ENAMEL has been protecting water pipe lines for many years. Actual inspection has proven positive protection against highly tuberculating waters for over twenty years.

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Why you should use GENUINE COREY HYDRANTS

Water to Nozzles quicker than other Hydrants.

Standpipe can be removed and replaced without shutting off water in main.

Ease of operation insured by knuckle joint principle.

Only 13 turns to completely open or completely close, but full flow with only 4 turns.

Nozzles screwed in — not leaded.

Can be lengthened without shutting off water.

Will not flood if broken.

Positive Drip — cannot freeze.

Standpipe can be revolved quarter turns — Nozzles always in right direction.

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TROY, N. Y.

DONALDSON IRON CO.

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CAST IRON PIPE

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New England Water Works Association

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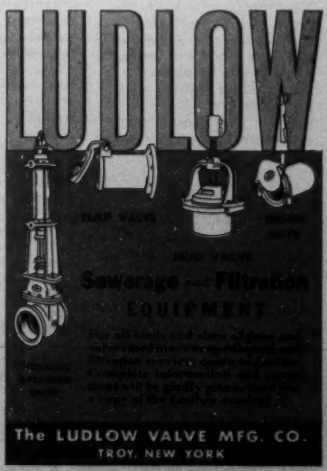


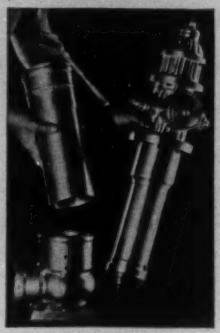
THE MEANEST FIRE-BUG

Shuts Off Water Before Starting Fires

The villain of this story is mean, bitter, and completely heartless, but so clever and tricky as to be difficult to stop. The innocent victim is the whole population—everybody everywhere who is threatened by winter fires. And you are the hero, the one person who can do something about it. . . . Zero weather is the meanest fire-bug. Zero weather shuts off the water at the very moment it is starting fires.

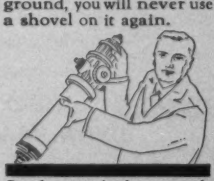
You know winter's dirty work. You know how its icy grasp closes on operating threads, blocks standpipes, and heaves hydrants loose from the mains at the very moment when furnaces are being pushed beyond their limits, when fires in buckets are warming the poor, and when alarms are ringing in from all sides.

When this happens, your department is faced with a life-and-death crisis. Then it is too late to prevent the damage, the loss, the helpless standing by.



The time to face that problem is right now. . . . Give your citizens hydrants that will not freeze. Beat winter before it starts. Buy no hydrant unless its standpipe is free from standing water, its operating threads protected from moisture, and the whole hydrant guarded against the thrust of frozen ground. Then—and only then—will you have a sure flow of water whenever fire strikes. . . . Study the Mathews Hydrant with winter in your mind. Note its positive and automatic drain valve, which must be open when the hydrant is closed, and which drains a properly set hydrant almost instantly. Look where its operating threads are located, sealed in a dry chamber where neither pressure from the main nor water from outside can freeze them together. Look especially at its loose protection case, free to slide up and down with the frost-heaved movement of the ground, but with never a strain on standpipe, valve, or main. . . . The Mathews Hydrant is a good hydrant because it is a winter hydrant. The construction which makes it absolutely safe against frost also makes it ideal for Summer. It is double-strong, permanent, and fool-proof.

Remember, also, that the Mathews protection case construction gives you a hydrant which can be unscrewed and completely lifted from the ground, overhauled, inspected, repaired if broken, or replaced—all with no digging whatever. Once the Mathews Hydrant is in the ground, you will never use a shovel on it again.



Study your hydrant problem as a winter problem. Write for cross section views. Or, we'll be glad to show a perfect model, indicating exactly how the Mathews works. Would that help persuade your council? We'll send a man.

MATHEWS HYDRANTS

and "SAND-SPUN" PIPE, a superior grade, centrifugally cast in sand moulds.

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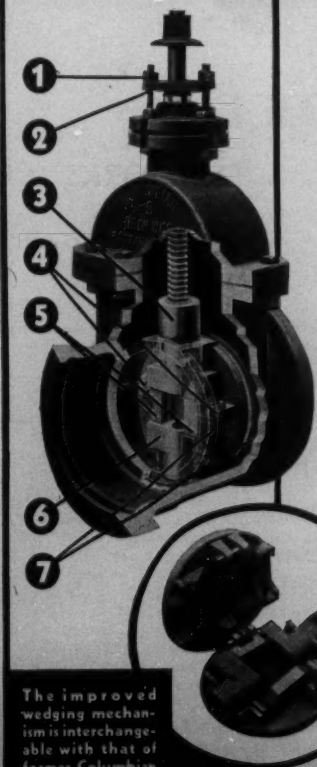
You GET THESE FEATURES *only in* COLUMBIAN



The improved wedging mechanism is interchangeable with that of former Columbian Gate Valves. At the right is the gate opened out to show construction.

IN the Columbian Gate Valve the stem never binds. The ball joint (2) between the bronze gland and follower prevents angular strains even when the packing nuts are tightened unequally. The non-rusting, cadmium plated packing bolts with bronze nuts (1) make repacking easy in either open or closed positions.

The illustrations show the construction of the wedging mechanism which accomplishes an evenly distributed "4-point contact" pressure practically at the outer edges of each disc. It consists of a top wedge (3) and bottom wedge (6) with two side spreaders (5) which equalize the pressure on the discs (7). When the discs reach the bottom of their travel, causing the top and bottom wedge nuts to converge, the inclined planes of the wedges force the discs against the seating surfaces with an absolutely evenly distributed pressure.

As a result of this construction there is no scraping of discs across seats because they are automatically contracted by a reversal of the spreading action before rising. Since the wedging pressure is applied at the outer edge of the discs, there is no possibility of sprung discs. The mechanism keeps all wedging action in a straight line so there is no side strain on the stem under any conditions.

Columbian Gate Valves do not leak because seat rings are machine finished and ground with faces absolutely parallel. The small, precise clearances between the discs effectively shear off all incrustations. Ask for descriptive bulletin.

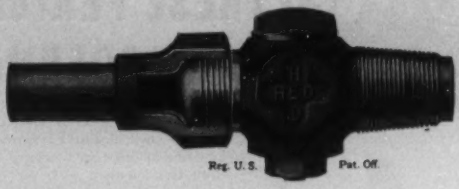
COLUMBIAN IRON WORKS
Chattanooga, Tennessee
Division of MUELLER CO.
Decatur, Illinois

Your FUTURE fire hydrant

Ask for facts about the fire hydrant with self-oiling top, safety flange and coupling and many other features that are combined in no other hydrant.

COLUMBIAN

FIRE HYDRANTS AND GATE VALVES



RED HED

BRASS GOODS FOR WATER WORKS

CORPORATIONS
TEE HEAD STOPS
LEVER HANDLE STOPS
WELL CONNECTIONS
TAPPING MACHINES
COPPER TUBE

CORRECT DESIGN, HAND GROUND
SUPERIOR WORKMANSHIP, 250 LBS. TEST

GOOSENECKS

ALL KINDS FOR

IRON PIPE—BRASS PIPE
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LEAD FLANGED or CUP JOINTS

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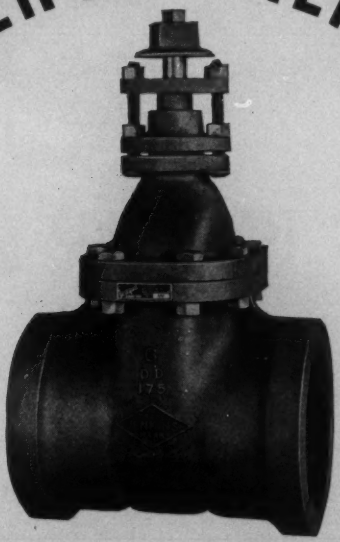


Fig. 883
Double Disc
Parallel Seat

—*makes ordinary duty easy for a Jenkins*

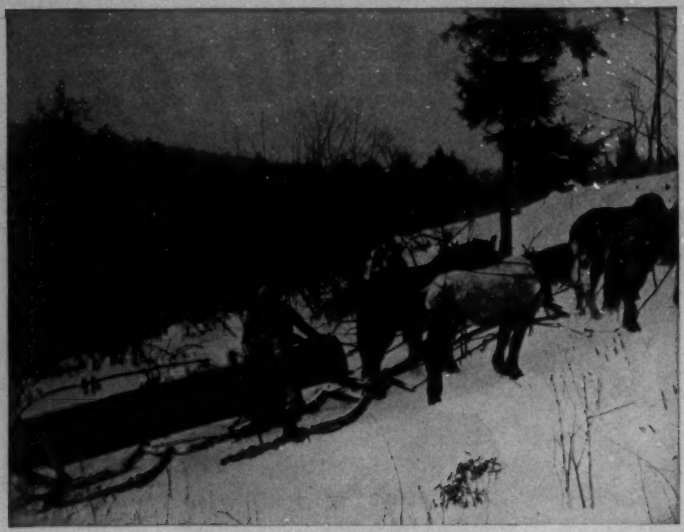
STRENGTH is emphasized in making Jenkins Iron Body Gate Valves for water works service. In both the Solid Wedge and the Double Disc Parallel Seat valves are many superior features that build up strength . . . that make a "Jenkins" capable of handling ordinary duty with ease. The result is longer valve life and less maintenance. This great reserve strength also enables a "Jenkins" to carry-on even if extraordinary strains are encountered.

When you need Iron Body Gates make your selection from the Jenkins Catalog. A special 32 page section gives you comprehensive data on Iron Body Gates in sizes from 2 inches to 48 inches; Cast Steel Gates; Electrically and Hydraulically Operated Gates; Indicator Posts; Floor Stands and Gearing arrangements. Use this Book to save time and safeguard your valve investment.

JENKINS BROS., 80 White Street, New York, N.Y.; 510 Main Street, Bridgeport, Conn.; 524 Atlantic Avenue, Boston, Mass.; 133 No. Seventh Street, Philadelphia, Pa.; 822 Washington Boulevard, Chicago, Ill.; JENKINS BROS., Limited, Montreal, Canada; London, England.

Jenkins Valves

BRONZE—IRON—STEEL SINCE 1864



Installing Super-de Lavaud Pipe in mountainous terrain and winter weather at Greenfield, Mass.

IMPACT RESISTANCE DOUBLED

The most economical material known to the engineering profession for the purpose of transporting water underground is cast iron pipe. Mains laid two centuries ago are still serving, having paid for themselves many times over. Yet the cast iron pressure pipe industry goes on improving this long-lived economical product. An important development of recent years is the Super-de Lavaud Process by which gray iron is centrifugally cast in a metal mold *without chill* — a trail-blazing technique, perfected and patented by this Company. The outstanding result is *doubled impact strength*. Users find that Super-de Lavaud Pipe is not only stronger and tougher but *more ductile*. Nearly nine million feet have been sold and installed in less than two years. Ask for descriptive literature.

U.S. SUPER-de LAVAUD PIPE

CAST WITHOUT CHILL IN A METAL MOLD

UNITED STATES PIPE AND FOUNDRY CO., General Offices: BURLINGTON, N. J.

Foundries and Sales Offices throughout the United States

The Journal of the New England Water Works Association

is a quarterly publication, containing the papers read at the meetings, together with reports of the discussions. Many of the contributions are from writers of the highest standing in their profession. It affords a convenient medium for the interchange of information and experience between the members, who are so widely separated as to find frequent meetings an impossibility. Its success has more than met the expectation of its projectors; there is a large and increasing demand for its issues, and every addition to its subscription list is a material aid in extending its field of usefulness. ALL MEMBERS OF THE ASSOCIATION RECEIVE THE JOURNAL IN PART RETURN FOR THEIR ANNUAL DUES; to all others the subscription is four dollars per annum.

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